CHAIN OF CUSTODY RECORD

Ricardo
Level 4, 3 Bowen Crescent
Melbourne 3004
Ph: (03) 9978 7823

Contact Name: Sophie Smith	Lab Quote ID:	Page: 1 of 1	**Eurofins** 6 Monterey Road, DANDENONG SOUTH VIC 3175
Project Manager (phone) 0423 744 529	Project Number: 30765.02	Purchase Order: 4503113369	**Ph** 03 8564 5000 Mobile: 0428 104 484
email for results: sophie.smith@ricardo.com	Project Name: Yannathan GME		**Contact:** Savini Suduweli SaviniSuduweli@eurofins.com

Special Comments/Directions/ :

Please provide results with ESDAT formats:

Please send invoices to:
Hanson – Yannathan Quarry
gunther.benedek@hanson.com.au
0409 256 503

Analytes

Lab ID	Sample ID	Date/Time	Matrix	Container	Dissolved Organic Carbon (DOC)	Nitrate, Nitrite, Ammonia, TKN	Chloride	Acrylamide
	QC02	12/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
				Total	1	1	1	1

1. Relinquished By:	LAB Received By: Jake	**Turn around time:** 24hr 48hr 5day Standard
Date & Time: 14/10/2022	Date & Time: 14/10 5:29	
Signature: Sophie Smith	Signature: 10.00 Ice	
2. Received By:	Report Number:	**Method of Shipment:** Courier Hand Delivered
Date & Time:	Laboratory Comments:	
Relinquished By:		# 931914
Date & Time:		14/10/22
Signature:		

Sample Receipt Advice

Company name:	Ricardo Energy Environment & Planning PL
Contact name:	Sophie Smith
Project name:	YANNATHAN GME
Project ID:	30765.02
Turnaround time:	5 Day
Date/Time received	Oct 14, 2022 5:29 PM
Eurofins reference	931914

Sample Information

- ✓ A detailed list of analytes logged into our LIMS, is included in the attached summary table.
- ✓ All samples have been received as described on the above COC.
- ✓ COC has been completed correctly.
- ✓ Attempt to chill was evident.
- ✓ Appropriately preserved sample containers have been used.
- ✓ All samples were received in good condition.
- ✓ Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.
- ✓ Appropriate sample containers have been used.
- ✓ Sample containers for volatile analysis received with zero headspace.
- ✗ Split sample sent to requested external lab.
- ✗ Some samples have been subcontracted.
- N/A Custody Seals intact (if used).

Notes

Contact

If you have any questions with respect to these samples, please contact your Analytical Services Manager:

Savini Suduweli on phone : or by email: SaviniSuduweli@eurofins.com

Results will be delivered electronically via email to Sophie Smith - Sophie.Smith@ricardo.com.

Note: A copy of these results will also be delivered to the general Ricardo Energy Environment & Planning PL email address.

eurofins

web: www.eurofins.com.au
email: EnviroSales@eurofins.com

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ABN: 50 005 085 521

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Auckland 1061
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IANZ# 1327

Christchurch
43 Detroit Drive
Rolleston,
Christchurch 7675
Tel: 0800 856 450
IANZ# 1290

Company Name:	Ricardo Energy Environment & Planning PL	**Order No.:**	4503113369
Address:	Level 4, 3 Bowen Crescent Melbourne VIC 3004	**Report #:**	931914
		Phone:	03 9978 7823
		Fax:	
Project Name:	YANNATHAN GME	**Received:**	Oct 14, 2022 5:29 PM
Project ID:	30765.02	**Due:**	Oct 21, 2022
		Priority:	5 Day
		Contact Name:	Sophie Smith

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Acrylamide*	Ammonia (as N)	Chloride	Dissolved Organic Carbon	Nitrate (as N)	Nitrite (as N)	Total Kjeldahl Nitrogen (as N)
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X
External Laboratory												
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**							
1	QC02	Oct 12, 2022		Water	M22-Oc0028390	X	X	X	X	X	X	X
Test Counts						1	1	1	1	1	1	1

eurofins | Environment Testing

Certificate of Analysis

Ricardo Energy Environment & Planning PL
Level 4, 3 Bowen Crescent
Melbourne
VIC 3004

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention: **Sophie Smith**

Report **931914-W**
Project name YANNATHAN GME
Project ID 30765.02
Received Date Oct 14, 2022

Client Sample ID			**QC02**
Sample Matrix			**Water**
Eurofins Sample No.			**M22-Oc0028390**
Date Sampled			**Oct 12, 2022**
Test/Reference	LOR	Unit	
Acrylamide*	1	mg/L	< 1
Ammonia (as N)	0.01	mg/L	0.32
Chloride	1	mg/L	1200
Dissolved Organic Carbon	5	mg/L	20
Nitrate (as N)	0.02	mg/L	< 0.02
Nitrite (as N)	0.02	mg/L	< 0.02
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	3.0

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Acrylamide*	Melbourne	Oct 14, 2022	7 Days
- Method: USEPA 8000 - Acrylamide			
Ammonia (as N)	Melbourne	Oct 14, 2022	28 Days
- Method: APHA 4500-NH3 Ammonia Nitrogen by FIA			
Chloride	Melbourne	Oct 14, 2022	28 Days
- Method: LTM-INO-4090 Chloride by Discrete Analyser			
Dissolved Organic Carbon	Melbourne	Oct 14, 2022	28 Days
- Method: APHA 5310B Dissolved Organic Carbon			
Nitrate (as N)	Melbourne	Oct 14, 2022	28 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Nitrite (as N)	Melbourne	Oct 14, 2022	2 Days
- Method: LTM-INO-4120 Analysis of NOx NO2 NH3 by FIA			
Total Kjeldahl Nitrogen (as N)	Melbourne	Oct 14, 2022	28 Days
- Method: APHA 4500-Norg B,D Total Kjeldahl Nitrogen by FIA			

Company Name: Ricardo Energy Environment & Planning PL
Address: Level 4, 3 Bowen Crescent
Melbourne
VIC 3004

Order No.: 4503113369
Report #: 931914
Phone: 03 9978 7823
Fax:

Received: Oct 14, 2022 5:29 PM
Due: Oct 21, 2022
Priority: 5 Day
Contact Name: Sophie Smith

Project Name: YANNATHAN GME
Project ID: 30765.02

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Acrylamide*	Ammonia (as N)	Chloride	Dissolved Organic Carbon	Nitrate (as N)	Nitrite (as N)	Total Kjeldahl Nitrogen (as N)
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X
External Laboratory												
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**							
1	QC02	Oct 12, 2022		Water	M22-Oc0028390	X	X	X	X	X	X	X
Test Counts						1	1	1	1	1	1	1

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**µg/L:** micrograms per litre
ppm: parts per million	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres

Terms

APHA	American Public Health Association
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

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QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Acrylamide*			mg/L	< 1			1	Pass	
Ammonia (as N)			mg/L	< 0.01			0.01	Pass	
Chloride			mg/L	< 1			1	Pass	
Nitrate (as N)			mg/L	< 0.02			0.02	Pass	
Nitrite (as N)			mg/L	< 0.02			0.02	Pass	
Total Kjeldahl Nitrogen (as N)			mg/L	< 0.2			0.2	Pass	
LCS - % Recovery									
Acrylamide*			%	102			70-130	Pass	
Ammonia (as N)			%	98			70-130	Pass	
Chloride			%	97			70-130	Pass	
Nitrate (as N)			%	101			70-130	Pass	
Nitrite (as N)			%	112			70-130	Pass	
Total Kjeldahl Nitrogen (as N)			%	104			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Acrylamide*	M22-Se0051906	NCP	%	93			70-130	Pass	
Ammonia (as N)	M22-Oc0027280	NCP	%	77			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	M22-Oc0024287	NCP	%	123			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Ammonia (as N)	M22-Oc0028412	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chloride	M22-Oc0028441	NCP	mg/L	1600	1800	9.9	30%	Pass	
Nitrate (as N)	M22-Oc0028412	NCP	mg/L	0.17	0.19	6.8	30%	Pass	
Nitrite (as N)	M22-Oc0028412	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Total Kjeldahl Nitrogen (as N)	M22-Oc0024299	NCP	mg/L	2.5	2.8	11	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised by:

Savini Suduweli	Analytical Services Manager
Joseph Edouard	Senior Analyst-Organic
Mary Makarios	Senior Analyst-Inorganic

Glenn Jackson
General Manager

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Eurofins shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Eurofins be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Unless indicated otherwise, the tests were performed on the samples as received.

CERTIFICATE OF ANALYSIS

Work Order	: **EM2220238**	Page	: 1 of 4
Client	: **HANSON CONSTRUCTION MATERIALS PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Contact	: Customer Services EM
Address	: ACCOUNTS PAYABLE LOCKED BAG 5018 PARRAMATTA NSW 2124	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9600
Project	: 30765.02	Date Samples Received	: 14-Oct-2022 15:40
Order number	: 4503113368	Date Analysis Commenced	: 14-Oct-2022
C-O-C number	: ----	Issue Date	: 21-Oct-2022 16:43
Sampler	: AH, SS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 9		
No. of samples analysed	: 9		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It is recognised that TKN is less than Ammonia as N for sample 3. However, the difference is within experimental variation of the methods.
- EP005:EM2220238 #3 & #8 Particular samples required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	LL8	LL9	LL13	LL15	LL16
			Sampling date / time	12-Oct-2022 00:00	12-Oct-2022 00:00	13-Oct-2022 00:00	13-Oct-2022 00:00	12-Oct-2022 00:00
Compound	CAS Number	LOR	Unit	EM2220238-001	EM2220238-002	EM2220238-003	EM2220238-004	EM2220238-005
				Result	Result	Result	Result	Result
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**288**	**1170**	**750**	**81**	**240**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.44**	**0.41**	**0.14**	**0.02**	**0.07**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.01**	<0.01	**0.06**	**0.02**	**0.98**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	<0.01	**0.06**	**0.02**	**0.98**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.7**	**0.7**	**0.1**	**0.5**	**0.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.7**	**0.7**	**0.2**	**0.5**	**1.6**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**11**	**14**	<5	**9**	**6**
EP233: Acrylamide								
Acrylamide	79-06-1	0.2	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	LL19	LL20	QC01	QC03	----
			Sampling date / time	13-Oct-2022 00:00	13-Oct-2022 00:00	12-Oct-2022 00:00	12-Oct-2022 00:00	----
Compound	CAS Number	LOR	Unit	EM2220238-006	EM2220238-007	EM2220238-008	EM2220238-009	--------
				Result	Result	Result	Result	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**134**	**216**	**1200**	<1	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.76**	**0.04**	**0.40**	<0.01	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**3.43**	<0.01	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**3.43**	<0.01	<0.01	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.1**	**0.6**	**0.5**	<0.1	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.1**	**4.0**	**0.5**	<0.1	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**11**	**1**	**18**	<1	----
EP233: Acrylamide								
Acrylamide	79-06-1	0.2	µg/L	<0.2	<0.2	<0.2	<0.2	----

Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology).

(WATER) EP233: Acrylamide

QUALITY CONTROL REPORT

Work Order	: **EM2220238**	Page	: 1 of 5
Client	: **HANSON CONSTRUCTION MATERIALS PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Contact	: Customer Services EM
Address	: ACCOUNTS PAYABLE LOCKED BAG 5018 PARRAMATTA NSW 2124	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9600
Project	: 30765.02	Date Samples Received	: 14-Oct-2022
Order number	: 4503113368	Date Analysis Commenced	: 14-Oct-2022
C-O-C number	: ----	Issue Date	: 21-Oct-2022
Sampler	: AH, SS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 9		
No. of samples analysed	: 9		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 4639795)									
EM2220222-004	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	8	8	0.0	No Limit
EM2220238-007	LL20	ED045G: Chloride	16887-00-6	1	mg/L	216	217	0.6	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 4642779)									
EM2220216-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.04	0.0	No Limit
EM2220238-009	QC03	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 4639794)									
EM2220228-003	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	0.05	0.05	0.0	No Limit
EM2220186-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 4639797)									
EM2220238-002	LL9	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 4642780)									
EM2220216-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.06	1.09	2.3	0% - 20%
EM2220238-009	QC03	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 4641207)									
EM2218306-043	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.2	2.2	0.0	0% - 20%
EM2218306-058	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.1	0.3	77.1	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 4641208)									
EM2220238-002	LL9	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.6	18.4	No Limit
EM2220256-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.5	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 4643946)									
EM2219956-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	10000 µg/L	11	0.0	0% - 50%
EM2220131-015	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	39	40	2.9	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EP005: Total Organic Carbon (TOC) (QC Lot: 4643947)									
EM2220238-003	LL13	EP005: Total Organic Carbon	----	1	mg/L	<5	<5	0.0	No Limit
EM2220248-002	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	8	8	0.0	No Limit
EP233: Acrylamide (QC Lot: 4646201)									
EM2220238-001	LL8	EP233: Acrylamide	79-06-1	0.2	µg/L	<0.2	<0.2	0.0	No Limit
EP2213460-001	Anonymous	EP233: Acrylamide	79-06-1	0.2	µg/L	<0.0002 mg/L	<0.2	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 4639795)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	104	85.0	115
				<1	1000 mg/L	103	85.0	122
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4642779)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	97.0	84.1	116
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4639794)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	105	90.9	112
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4639797)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	105	90.9	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4642780)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	102	90.0	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4641207)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	5 mg/L	90.2	70.0	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4641208)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	5 mg/L	90.8	70.0	117
EP005: Total Organic Carbon (TOC) (QCLot: 4643946)								
EP005: Total Organic Carbon	----	1	mg/L	<1	100 mg/L	91.2	81.2	110
EP005: Total Organic Carbon (TOC) (QCLot: 4643947)								
EP005: Total Organic Carbon	----	1	mg/L	<1	100 mg/L	92.8	81.2	110
EP233: Acrylamide (QCLot: 4646201)								
EP233: Acrylamide	79-06-1	0.2	µg/L	<0.2	2 µg/L	107	70.0	128

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 4639795)							
EM2220222-007	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	109	70.0	142
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4642779)							
EM2220238-001	LL8	EK055G: Ammonia as N	7664-41-7	1 mg/L	104	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4639794)							
EM2220186-005	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	101	80.0	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4639797)							
EM2220238-003	LL13	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	99.6	80.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4642780)							
EM2220238-001	LL8	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	98.0	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4641207)							
EM2218306-044	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	87.8	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4641208)							
EM2220238-003	LL13	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.5	70.0	130
EP005: Total Organic Carbon (TOC) (QCLot: 4643946)							
EM2219956-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	98.1	76.6	125
EP005: Total Organic Carbon (TOC) (QCLot: 4643947)							
EM2220238-004	LL15	EP005: Total Organic Carbon	----	100 mg/L	108	76.6	125
EP233: Acrylamide (QCLot: 4646201)							
EM2220238-001	LL8	EP233: Acrylamide	79-06-1	2 µg/L	102	70.0	128

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: EM2220238	Page	
Client	: HANSON CONSTRUCTION MATERIALS PTY LTD	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Telephone	: +61-3-8549 9600
Project	: 30765.02	Date Samples Received	: 14-Oct-2022
Site	: ----	Issue Date	: 21-Oct-2022
Sampler	: AH, SS	No. of samples received	: 9
Order number	: 4503113368	No. of samples analysed	: 9

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G) LL8, LL16, QC03	LL9, QC01,	**12-Oct-2022**	----	----	----	**17-Oct-2022**	09-Nov-2022	✓
Clear Plastic Bottle - Natural (ED045G) LL13, LL19,	LL15, LL20	**13-Oct-2022**	----	----	----	**17-Oct-2022**	10-Nov-2022	✓
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G) LL8, LL16, QC03	LL9, QC01,	**12-Oct-2022**	----	----	----	**20-Oct-2022**	09-Nov-2022	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G) LL13, LL19,	LL15, LL20	**13-Oct-2022**	----	----	----	**20-Oct-2022**	10-Nov-2022	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G) LL8, LL16, QC03	LL9, QC01,	**12-Oct-2022**	----	----	----	**14-Oct-2022**	14-Oct-2022	✓
Clear Plastic Bottle - Natural (EK057G) LL13, LL19,	LL15, LL20	**13-Oct-2022**	----	----	----	**14-Oct-2022**	15-Oct-2022	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G) LL8, LL16, QC03	LL9, QC01,	**12-Oct-2022**	----	----	----	**19-Oct-2022**	09-Nov-2022	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G) LL13, LL19,	LL15, LL20	**13-Oct-2022**	----	----	----	**19-Oct-2022**	10-Nov-2022	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
***Container** / Client Sample ID(s)*		**Date extracted**	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) LL8, LL9, LL16, QC01, QC03	**12-Oct-2022**	**18-Oct-2022**	09-Nov-2022	✓	**18-Oct-2022**	09-Nov-2022	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G) LL13, LL15, LL19, LL20	**13-Oct-2022**	**18-Oct-2022**	10-Nov-2022	✓	**18-Oct-2022**	10-Nov-2022	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) LL8, LL9, LL16, QC01, QC03	**12-Oct-2022**	**----**	----	----	**18-Oct-2022**	09-Nov-2022	✓
Amber TOC Vial - Sulfuric Acid (EP005) LL13, LL15, LL19, LL20	**13-Oct-2022**	**----**	----	----	**18-Oct-2022**	10-Nov-2022	✓
EP233: Acrylamide							
Amber Glass Bottle - Unpreserved (EP233) LL8, LL9, LL16, QC01, QC03	**12-Oct-2022**	**----**	----	----	**19-Oct-2022**	19-Oct-2022	✓
Amber Glass Bottle - Unpreserved (EP233) LL13, LL15, LL19, LL20	**13-Oct-2022**	**----**	----	----	**19-Oct-2022**	20-Oct-2022	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acrylamide	EP233	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	21	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acrylamide	EP233	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Acrylamide	EP233	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Acrylamide	EP233	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm.
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM Schedule B(3)
Acrylamide	EP233	WATER	In house: LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Quantification is via internal standardisation using the deuterated analogue.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **EM2220238**		
Client	: **Ricardo Energy, Environment & Planning**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Contact	: Katie Davis
Address	: L4, 3 BOWEN CRESCENT MELBOURNE 3004	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: sophie.smith@ricardo.com	E-mail	: katie.davis@alsglobal.com
Telephone	: ----	Telephone	: +61-3-8549 9600
Facsimile	: ----	Facsimile	: +61-3-8549 9626
Project	: 30765.02	Page	: 1 of 2
Order number	: 4503113368	Quote number	: EM2018PLCCON0009 (ME/222)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: AH, SS		

Dates

Date Samples Received	: 14-Oct-2022 15:40	Issue Date	: 14-Oct-2022
Client Requested Due Date	: 25-Oct-2022	Scheduled Reporting Date	: **25-Oct-2022**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 6.1°C - Ice Bricks present
Receipt Detail	:	No. of samples received / analysed	: 9 / 9

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **The scheduled reporting date has been extended due to analytical testing conducted by ALS interstate laboratories.**
- **Please direct any queries related to sample condition / numbering / breakages to Client Services.**
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **Analytical work for this work order will be conducted at ALS Springvale and ALS Sydney.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The laboratory will process these samples unless instructions are received from you indicating you do not wish to proceed. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	*Sampling date / time*	*Sample ID*	WATER - ED045G Chloride by Discrete Analyser	WATER - EP233 Acrylamide by LC-MSMS	WATER - NT-07 Total Nitrogen + NO2 + NO3 + NH3
EM2220238-001	12-Oct-2022 00:00	LL8	✓	✓	✓
EM2220238-002	12-Oct-2022 00:00	LL9	✓	✓	✓
EM2220238-003	13-Oct-2022 00:00	LL13	✓	✓	✓
EM2220238-004	13-Oct-2022 00:00	LL15	✓	✓	✓
EM2220238-005	12-Oct-2022 00:00	LL16	✓	✓	✓
EM2220238-006	13-Oct-2022 00:00	LL19	✓	✓	✓
EM2220238-007	13-Oct-2022 00:00	LL20	✓	✓	✓
EM2220238-008	12-Oct-2022 00:00	QC01	✓	✓	✓
EM2220238-009	12-Oct-2022 00:00	QC03	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

Hanson Yannathan Quarry

- A4 - AU Tax Invoice (INV)	Email	gunther.benedek@hanson.com.au

SOPHIE SMITH

- *AU Certificate of Analysis - NATA (COA)	Email	sophie.smith@ricardo.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	sophie.smith@ricardo.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	sophie.smith@ricardo.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	sophie.smith@ricardo.com
- A4 - AU Tax Invoice (INV)	Email	sophie.smith@ricardo.com
- Chain of Custody (CoC) (COC)	Email	sophie.smith@ricardo.com
- EDI Format - ENMRG (ENMRG)	Email	sophie.smith@ricardo.com
- EDI Format - ESDAT (ESDAT)	Email	sophie.smith@ricardo.com

CHAIN OF CUSTODY RECORD

Ricardo
Level 4, 3 Bowen Crescent
Melbourne 3004
Ph: (03) 9978 7823

Contact Name: Sophie Smith	Lab Quote ID:	Page: 1 of 1	ALS	4 Westall Road, Springvale 3166
Project Manager (phone): 0423 744 529	Project Number: 30765.02	Purchase Order: 4503113368	Ph	03 8549 9600 **Direct** 03 8549 9644
email for results: sophie.smith@ricardo.com	Project Name: Yannathan GME		Contact:	Katie Davis Katie.Davis@ALSglobal.com

Special Comments/Directions/ :

Please provide results with ESDAT formats:

Please send invoices to:
Hanson – Yannathan Quarry
gunther.benedek@hanson.com.au
0409 256 503

Environmental Division
Melbourne
Work Order Reference
EM2220238
Telephone : + 61-3-8549 9600

Lab ID	Sample ID	Date/Time	Matrix	Container	Dissolved Organic Carbon (DOC)	Nitrate, Nitrite, Ammonia, TKN	Chloride	Acrylamide
1	LL8	12/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
2	LL9	12/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
3	LL13	13/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
4	LL15	13/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
5	LL16	12/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
6	LL19	13/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
7	LL20	13/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
8	QC01	12/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
9	QC03	12/10/2022	Water	3 plastic, 1 vial, 1 amber	1	1	1	1
				Total	9	9	9	9

1. Relinquished By: Sophie Smith	LAB Received By: KSF	Turn around time:
Date & Time: 14 October 2022	Date & Time: 14/10/22 15:40	24hr 48hr 5day **Standard**
Signature:	Signature:	Method of Shipment:
2. Received By:	Report Number:	Courier Hand Delivered
Date & Time:	Laboratory Comments:	
Relinquished By:		
Date & Time:		
Signature:		

CERTIFICATE OF ANALYSIS

Work Order	: **EM2220243**	Page	: 1 of 3
Client	: **HANSON CONSTRUCTION MATERIALS PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Contact	: Customer Services EM
Address	: ACCOUNTS PAYABLE LOCKED BAG 5018 PARRAMATTA NSW 2124	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9600
Project	: 30765.02	Date Samples Received	: 14-Oct-2022 15:40
Order number	: 4503113368	Date Analysis Commenced	: 14-Oct-2022
C-O-C number	: ----	Issue Date	: 20-Oct-2022 16:24
Sampler	: AH, SS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 1		
No. of samples analysed	: 1		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- It is recognised that TKN is less than Ammonia as N for sample 1. However, the difference is within experimental variation of the methods.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	POND	----	----	----	----
			Sampling date / time	13-Oct-2022 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EM2220243-001	--------	--------	--------	--------
				Result	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**178**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.14**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.05**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.05**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.2**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	<1	----	----	----	----
EP233: Acrylamide								
Acrylamide	79-06-1	0.2	µg/L	<0.2	----	----	----	----

Inter-Laboratory Testing

Analysis conducted by ALS Sydney, NATA accreditation no. 825, site no. 10911 (Chemistry) 14913 (Biology).

(WATER) EP233: Acrylamide

Environmental

QUALITY CONTROL REPORT

Work Order	: **EM2220243**	Page	: 1 of 4
Client	: **HANSON CONSTRUCTION MATERIALS PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Contact	: Customer Services EM
Address	: ACCOUNTS PAYABLE LOCKED BAG 5018 PARRAMATTA NSW 2124	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9600
Project	: 30765.02	Date Samples Received	: 14-Oct-2022
Order number	: 4503113368	Date Analysis Commenced	: 14-Oct-2022
C-O-C number	: ----	Issue Date	: 20-Oct-2022
Sampler	: AH, SS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 1		
No. of samples analysed	: 1		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
ED045G: Chloride by Discrete Analyser (QC Lot: 4639795)									
EM2220222-004	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	8	8	0.0	No Limit
EM2220238-007	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	216	217	0.6	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 4642779)									
EM2220216-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.04	0.0	No Limit
EM2220238-009	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 4639797)									
EM2220238-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 4642780)									
EM2220216-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.06	1.09	2.3	0% - 20%
EM2220238-009	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 4641208)									
EM2220238-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.7	0.6	18.4	No Limit
EM2220256-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.5	0.0	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 4643947)									
EM2220238-003	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	<5	<5	0.0	No Limit
EM2220248-002	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	8	8	0.0	No Limit
EP233: Acrylamide (QC Lot: 4646201)									
EM2220238-001	Anonymous	EP233: Acrylamide	79-06-1	0.2	µg/L	<0.2	<0.2	0.0	No Limit
EP2213460-001	Anonymous	EP233: Acrylamide	79-06-1	0.2	µg/L	<0.0002 mg/L	<0.2	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 4639795)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	104	85.0	115
				<1	1000 mg/L	103	85.0	122
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4642779)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	97.0	84.1	116
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4639797)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	105	90.9	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4642780)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	102	90.0	117
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4641208)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	5 mg/L	90.8	70.0	117
EP005: Total Organic Carbon (TOC) (QCLot: 4643947)								
EP005: Total Organic Carbon	----	1	mg/L	<1	100 mg/L	92.8	81.2	110
EP233: Acrylamide (QCLot: 4646201)								
EP233: Acrylamide	79-06-1	0.2	µg/L	<0.2	2 µg/L	107	70.0	128

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 4639795)							
EM2220222-007	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	109	70.0	142
EK055G: Ammonia as N by Discrete Analyser (QCLot: 4642779)							
EM2220238-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	104	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 4639797)							
EM2220238-003	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	99.6	80.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 4642780)							
EM2220238-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	98.0	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 4641208)							
EM2220238-003	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.5	70.0	130

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	High
EP005: Total Organic Carbon (TOC) (QCLot: 4643947)							
EM2220238-004	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	108	76.6	125
EP233: Acrylamide (QCLot: 4646201)							
EM2220238-001	Anonymous	EP233: Acrylamide	79-06-1	2 µg/L	102	70.0	128

Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2220243**	Page	: 1 of 4
Client	: **HANSON CONSTRUCTION MATERIALS PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Telephone	: +61-3-8549 9600
Project	: 30765.02	Date Samples Received	: 14-Oct-2022
Site	: ----	Issue Date	: 20-Oct-2022
Sampler	: AH, SS	No. of samples received	: 1
Order number	: 4503113368	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) POND	**13-Oct-2022**	**----**	----	----	**17-Oct-2022**	10-Nov-2022	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) POND	**13-Oct-2022**	**----**	----	----	**20-Oct-2022**	10-Nov-2022	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) POND	**13-Oct-2022**	**----**	----	----	**14-Oct-2022**	15-Oct-2022	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) POND	**13-Oct-2022**	**----**	----	----	**19-Oct-2022**	10-Nov-2022	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) POND	**13-Oct-2022**	**18-Oct-2022**	10-Nov-2022	✓	**18-Oct-2022**	10-Nov-2022	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) POND	**13-Oct-2022**	**----**	----	----	**18-Oct-2022**	10-Nov-2022	✓
EP233: Acrylamide							
Amber Glass Bottle - Unpreserved (EP233) POND	**13-Oct-2022**	**----**	----	----	**19-Oct-2022**	20-Oct-2022	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acrylamide	EP233	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	9	**22.22**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acrylamide	EP233	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Acrylamide	EP233	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Acrylamide	EP233	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm.
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM Schedule B(3)
Acrylamide	EP233	WATER	In house: LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Quantification is via internal standardisation using the deuterated analogue.

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **EM2220243**		
Client	: **Ricardo Energy, Environment & Planning**	Laboratory	: Environmental Division Melbourne
Contact	: SOPHIE SMITH	Contact	: Katie Davis
Address	: L4, 3 BOWEN CRESCENT MELBOURNE 3004	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: sophie.smith@ricardo.com	E-mail	: katie.davis@alsglobal.com
Telephone	: ----	Telephone	: +61-3-8549 9600
Facsimile	: ----	Facsimile	: +61-3-8549 9626
Project	: 30765.02	Page	: 1 of 2
Order number	: 4503113368	Quote number	: EM2018PLCCON0009 (ME/222)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	: ----		
Sampler	: AH, SS		

Dates

Date Samples Received	: 14-Oct-2022 15:40	Issue Date	: 14-Oct-2022
Client Requested Due Date	: 25-Oct-2022	Scheduled Reporting Date	: **25-Oct-2022**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 6.1°C - Ice Bricks present
Receipt Detail	:	No. of samples received / analysed	: 1 / 1

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **The scheduled reporting date has been extended due to analytical testing conducted by ALS interstate laboratories.**
- **Please direct any queries related to sample condition / numbering / breakages to Client Services.**
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **Analytical work for this work order will be conducted at ALS Springvale and ALS Sydney.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The laboratory will process these samples unless instructions are received from you indicating you do not wish to proceed. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	*Sampling date / time*	*Sample ID*	WATER - ED045G Chloride by Discrete Analyser	WATER - EP233 Acrylamide by LC-MSMS	WATER - NT-07 Total Nitrogen + NO2 + NO3 + NH3
EM2220243-001	13-Oct-2022 00:00	POND	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

Hanson Yannathan Quarry

- A4 - AU Tax Invoice (INV)	Email	gunther.benedek@hanson.com.au

SOPHIE SMITH

- *AU Certificate of Analysis - NATA (COA)	Email	sophie.smith@ricardo.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	sophie.smith@ricardo.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	sophie.smith@ricardo.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	sophie.smith@ricardo.com
- A4 - AU Tax Invoice (INV)	Email	sophie.smith@ricardo.com
- Chain of Custody (CoC) (COC)	Email	sophie.smith@ricardo.com
- EDI Format - ENMRG (ENMRG)	Email	sophie.smith@ricardo.com
- EDI Format - ESDAT (ESDAT)	Email	sophie.smith@ricardo.com

CHAIN OF CUSTODY RECORD

Ricardo
Level 4, 3 Bowen Crescent
Melbourne 3004
Ph: (03) 9978 7823

RICARDO

Contact Name:	Sophie Smith	Lab Quote ID:	Page: 1 of 1	ALS	4 Westall Road, Springvale 3166
Project Manager (phone):	0423 744 529	Project Number: 30765.02	Purchase Order: 4503113368	Ph	03 8549 9600 **Direct** 03 8549 9644
email for results:	sophie.smith@ricardo.com	Project Name: Yannathan GME		**Contact:**	Katie Davis Katie.Davis@ALSglobal.com

Special Comments/Directions/ :

Please batch separately to other water samples (Separate COC)

Please provide results with ESDAT formats:

Please send invoices to:
Hanson – Yannathan Quarry
gunther.benedek@hanson.com.au
0409 256 503

Environmental Division
Melbourne
Work Order Reference
EM2220243

Telephone : + 61-3-8549 9600

Analytes

Lab ID	Sample ID	Date/Time	Matrix	Container	Dissolved Organic Carbon (DOC)	Nitrate, Nitrite, Ammonia, TKN	Chloride	Acrylamide
1	POND	13/10/2022	Water	2 plastic, 1 vial, 1 amber	1	1	1	1
				Total	1	1	1	1

1. Relinquished By: Sophie Smith	LAB Received By: KSF	Turn around time:
Date & Time: 14 October 2022	Date & Time: 14/10/22 15.40	24hr 48hr 5day Standard
Signature:	Signature:	Method of Shipment:
2. Received By:	Report Number:	Courier Hand Delivered
Date & Time:	Laboratory Comments:	
Relinquished By:		
Date & Time:		
Signature:		

Appendix E Data Validation Report

APPENDIX E – Quality Assurance and Quality Control

Ricardo has adopted quality assurance and quality control procedures consistent with guidance from the following sources:

- EPA Victoria, 2009, Sampling and Analysis of Waters, Wastewaters, Soils and Waste, Industrial Waste Resource Guidelines (IWRG) Publication 701
- NEPC 1999. National Environmental Protection (Assessment of Site Contamination) Measure 1999, National Environment Protection Council as amended 15 May 2013, Comlaw No. F2013C00288
- Standards Australia AS/NZ, Australian/New Zealand Standard 2005, AS4482.1:2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil – Non-Volatile and Semi-Volatile Compounds.
- Standards Australia AS/NZ, Australian/New Zealand Standard 1998, AS 5667.1:1998 Water Quality – Sampling Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples.
- USEPA 2006, Guidance on Systematic Planning Using the Data Quality Objective Process (EPA QA/G-4), EPA/240/B-06, February 2006.
- USEPA 2008, Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8), EPA/240/R-02/004, published November 2007, re-issued 7 January 2008.
- USEPA – Contract Laboratory Program http://www.epa.gov/superfund/programs/clp/index.htm

1 Field Procedures

A summary of the field quality assurance and quality control procedures conducted as part of the investigation is summarised below in **Table 1**.

Table 1: Field Quality Assurance Quality Control

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
Field Calibration	Field instruments are well maintained and fit for purpose.	All field instruments / equipment is calibrated prior to use. Calibration certificates and records are to be provided.	AS4482.1 (2005) NEPM (2013) – Schedule B2	Y	Calibration of field equipment was completed prior to use by the equipment provider. Calibration certificates are provided in Appendix F.
Sample Preservation and Storage	Samples preserved, stored and transported in such a manner such that sample integrity is maintained	0 – 6 degrees Celsius	NEPM (2013) – Schedule B3	Y	Samples were preserved, transported and stored appropriately. Sample Receipt Notifications (SRNs) are provided in Appendix D. Some samples were noted as having been received by ALS laboratories at a temperature of 6.1°C, however this fell within an acceptable range of variation and ice was noted as present.
Frequency of Quality Control Measures	Field blanks, field duplicates and triplicates are above minimum requirements	Field duplicate and field triplicate samples at one per 20 samples collected. One rinsate blank per equipment piece per day requiring decontamination. One trip blank per cooler where volatiles are CoPC.	AS4482.1-2005	Y N	One blind (duplicate) and one split (triplicate) sample were collected for a total of seven primary samples. One rinsate was collected on the first day of sampling. No rinsates were collected on the second day as this was unplanned. CoPCs are not considered volatile and therefore no trip blank was collected.
Field Duplicates (Blind Replicates)	Relative percentage difference (RPD) between parent sample and duplicate sample within acceptable range	Results <10 x LOR = no RPD range. Results >10 x LOR = RPD < 30%	ASC NEPM (Schedule B3)	N	An RPD exceedance was reported between the primary and duplicate sample for Total Kjeldahl Nitrogen as well as Total Nitrogen. See Table 2 and section 1.1 below, for further comment.

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
Field Triplicates (Split Samples)	Relative percentage difference (RPD) between parent sample and triplicate sample within acceptable range	Results <10 x LOR = no RPD range Results >10 x LOR = RPD < 30%	ASC NEPM (Schedule B3)	N	An RPD exceedance was reported between the primary and triplicate sample for Total Kjeldahl Nitrogen. See Table 3 and Section 1.2 below, for further comment.
Rinsate Blanks	Analytes reported at concentrations <LOR	<LOR	AS4482.1-2005 ASC NEPM (Schedule B3)	Y	All analytes were reported below the laboratory LOR.
Trip Blanks	Analytes reported at concentrations <LOR	<LOR	AS4482.1-2005 ASC NEPM (Schedule B3)	N/A	No triplicate blanks were required.

1.1 Field Duplicate RPD Exceedances

Exceedances of the acceptable RPD range were reported for a number of analytes in groundwater samples. A summary of the RPD exceedances is provided in the **Table 2** below.

Table 2: Field Triplicate RPDs

Analyte	Primary Sample ID	Primary Sample Concentration	QC Sample ID	QC Sample Concentration	RPD (%)
Total Kjeldahl Nitrogen (TKN)	LL09	0.7mg/L	QC01	0.5mg/L	-33%
Nitrogen Total	LL09	0.7mg/L	QC01	0.5mg/L	-33%

The elevated RPDs reported, when adjusted for results in the range of 1 – 10 x the LOR (0.1 mg/L), is within the adjusted acceptable RPD of 80%..

1.2 Field Triplicate RPD Exceedances

Exceedances of the acceptable RPD range were reported for one analyte in groundwater samples. A summary of the RPD exceedances is provided in the **Table 3** below.

Table 3: Field Triplicate RPDs

Analyte	Primary Sample ID	Primary Sample Concentration	QC Sample ID	QC Sample Concentration	RPD (%)
Total Kjeldahl Nitrogen (TKN)	LL09	0.7	QC02	3.0	124

The elevated RPDs reported between LL09 and QC02 may be the result of slight differences in the method of analysis between the two laboratories. The highest concentration has been adopted for interpretive use. The presence of a limited number of RPD outliers is not considered to affect the interpretation of the data.

2 Laboratory Procedures

All samples were analysed by ALS (primary laboratory) and Eurofins (secondary laboratory). A summary of the laboratory quality assurance and quality control procedures conducted as part of the investigation are summarised in **Table 4** below.

Table 4: Laboratory QC Procedure Assessment

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
Sample Holding Times	Samples received and extracted by the laboratory within recommended holding times.	As specified by a NATA accredited laboratory.	AS4482.1-2005; IWRG 701; ALS QC Requirements	Y	All samples extracted within the holding times.
Frequency of Quality Control Samples	QC samples analysed at a rate equal to or greater than the minimum requirements	1:10 Laboratory Duplicates; 1:20 Matrix Spikes 1:20 LCS; 1:20 Method Blanks	NEPM 2013 B3 & ALS QC Standard	Y	The frequency of quality control samples was within acceptable limits.
Sample Analysis	Samples analysed for chemicals as required on COC via appropriate laboratory techniques.	Samples analysed by a NATA accredited laboratory.	Ricardo Field Procedures	N	Samples were submitted to the laboratory and analysed for the selected suite. Samples were submitted for Dissolved Organic Carbon but had not been field filtered,

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
					so were analysed for Total Organic Carbon instead.
Limits of Reporting	Laboratory reporting limits to be below relevant screening criteria.	LOR< lowest applicable screening/assessment criteria.	AS4482.1-2005	N	All LORs for primary and duplicate samples were below the lowest applicable screening / assessment criteria. The LOR for one analyte in the triplicate sample was above assessment criteria. Further comment provided in **section 2.1**.
Laboratory Method Blank	Analytes reported at concentrations below the laboratory limit or reporting.	<LOR	US EPA Contract Laboratory Program	Y	All laboratory method blanks were <LOR. Method blanks are 100% complete.
Laboratory Duplicates	RPD between duplicate samples within an acceptable range.	Results <10 x the LOR – No RPD range Results between 10-20 x the LOR – RPD between 0-50% Results >20 x LOR – RPD between 0-20%	NATA laboratory practice.	Y	There were no laboratory duplicate RPDs reported outside the acceptable range.
Matrix Spike Recoveries	Recoveries within adopted acceptability range.	As specified in laboratory QC report, if applicable. If not specified 70-130% adopted.	NATA laboratory practice.	Y	There were no Matrix Spike recoveries reported outside the acceptable range. Matrix Spike results are 100% complete.
Laboratory Control Spike (LCS) Recoveries	Recoveries within adopted acceptability range.	Specific to chemicals analysed.	Dynamic recovery limits for individual compounds.	Y	There were no LCS recovery outliers reported. LCS results are 100% complete.
Surrogate Spike Recoveries	Recoveries within adopted acceptability range.	As specified in laboratory QC report, if applicable. If not specified 70-130% adopted.	NATA laboratory practice.	Y	There were no surrogate spike recoveries reported outside the acceptable range.

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
					Surrogate spike results are 100% complete

2.1 Limit of Reporting Outliers

Limit of reporting outliers are summarised in **Table 5** below.

Table 5: Limit of Reporting Outliers

Analyte	Sample ID	Assessment Criteria Value	Laboratory	Laboratory Limit of Reporting	Value Reported
Acrylamide	QC02	<0.2µg/L	Eurofins Scientific	1000µg/L	<1000µg/L

The limit of reporting of Acrylamide for the sample sent to Eurofins Scientific is many times that required for assessment under the chosen criteria. The raised detection limits are not considered to have affected the interpretation of the data as they apply only to the triplicate sample. Primary and duplicate samples still provide confident data for interpretation of the results.

3 Data Collation and Data Assessment Procedures

A summary of the data collation and data assessment quality assurance and quality control procedures conducted as part of the investigation are summarised in **Table 6** below.

Table 6: Summary of Data Quality

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
Comparison of field observations and laboratory results.	Check of field observations against laboratory results to determine if the results were compatible.	Field and laboratory samples were relatively consistent (i.e. samples with evidence of odours, staining or high PID readings reported comparably high concentrations.	Ricardo internal review procedure	Y	There was not visual or olfactory evidence of contamination in the samples, which is consistent with the results.

Data Quality Objectives		Limits of Acceptability	Reference(s)	Pass (Y/N)	Details / Comment
The data presented in results tables is consistent with laboratory provided data	10% check of results table compared to Certificate of Analysis. 100% check to be completed if any errors noted.	Any differences in data are not acceptable and are required to be resolved.	Ricardo internal review procedure	Y	10% check completed, no differences in report tables and laboratory reported data noted.
Appropriate assessment criteria for data has been used in report tables.	100% check of adopted guidelines against published guideline values	Any differences in guidelines are not acceptable and are required to be resolved.	Ricardo internal review procedure	Y	The adopted guidelines provided with the report tables were correct.

4 Anomalous Results

RPD exceedances were reported total Kjeldahl Nitorgen for the split triplicate. However these RPD outliers are considered the result of slight differences in the method of analysis between the two laboratories and are not considered to significantly affect the overall quality of the dataset.

The limit of reporting of acrylamide for the sample sent to Eurofins Scientific is above that required for assessment under the chosen criteria. The raised detection limits are not considered to have affected the interpretation of the data as they apply only to the triplicate sample. Primary and duplicate samples still provide confident data for interpretation of the results.

There were no anomalous results reported.

5 Overall Data Assessment

Based on the above review, data is believed to be of suitable quality for interpretive use and to meet the project objectives.

Appendix F Calibration Certificates

Multi Parameter Water Meter

Instrument YSI ProDSS
Serial No. 20F162173

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
	6. Turbidity	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		377403	0 ppm
2. Conductivity		2760uS		385047	2760uS
3. pH7		pH 7.00		386467	pH 7.00
4. pH4		pH 4.00		384826	pH 4.00
5. ORP mV		235.32		371983/387511	235.32
6. Temp °C		19.4		163377	19.4
7. Turbidity		100NTU		387519	100

Calibrated by: Harrison Meers

Calibration date: 11-Oct-22

Next calibration due: 9-Apr-23

Multi Parameter Water Meter

Instrument YSI ProDSS
Serial No. 15J101500

Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
	6. Turbidity	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		1911294839	0 ppm
2. Conductivity		2760uS		3697374	2760uS
3. pH7		pH 7.00		368081	pH 7.00
4. pH4		pH 4.00		367234	pH 4.00
5. ORP mV		237.08		365451/361534	237.08
6. Temp °C		18.6		163377	20.2

Calibrated by: Harrison Meers

Calibration date: 11-Oct-22

Next calibration due: 9-Apr-23

T: +61 3 9978 7823
E: plc.admin@ricardo.com
W: ricardo.com

Appendix D Water balance calculations

Yannathan water balance - Average rainfall

Assumptions:
clay perimeter bunds effectively preclude lateral inflow and outflow
27 Dust suppression from Dec-Mar inclusive (25 days/month)in m3/day
19.5 Licence allocation (ML)

		Stage 19																												
		Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25
Rainfall (ave)	mm	57	47	54	72	81	86	82	93	89	86	78	73	57	47	54	72	81	86	82	93	89	86	78	73	57	47	54	72	81
Morton Evaporation (ave)	mm	161	131	104	62	34	21	26	45	71	109	133	155	161	131	104	62	34	21	26	45	71	109	133	155	161	131	104	62	34
Rainfall to dams	m3	3013	2480	2866	3808	4273	4508	4334	4902	4692	4518	4114	3864	3013	2480	2866	3808	4273	4508	4334	4902	4692	4518	4114	3864	3013	2480	2866	3808	4273
inflow to dry excavation	m3	12123	10949	12123	11732	12123	11732	12123	12123	11732	12123	11732	12123	12123	10949	12123	11732	12123	11732	12123	12123	11732	12123	11732	12123	10795	9750	10795	10446	10795
inflow from base	m3	2361	2133	2361	2285	2361	2285	2361	2361	2285	2361	2285	2361	2361	2133	2361	2285	2361	2285	2361	2361	2285	2361	2285	2361	3132	2829	3132	3031	3132
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	17497	15562	17350	17824	18757	18524	18818	19386	18709	19002	18131	18348	17497	15562	17350	17824	18757	18524	18818	19386	18709	19002	18131	18348	16940	15058	16792	17284	18200
Evaporation from dams	m3	8477	6923	5483	3253	1790	1117	1355	2361	3725	5762	7012	8154	8477	6923	5483	3253	1790	1117	1355	2361	3725	5762	7012	8154	8477	6923	5483	3253	1790
outflow from water storage	m3	21752	19647	21752	21050	21752	21050	21752	21752	21050	21752	21050	21752	21752	19647	21752	21050	21752	21050	21752	21752	21050	21752	21050	21752	21752	19647	21752	21050	21752
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0
TOTAL OUTFLOWS	m3	32529	28869	29534	25928	25167	23792	24732	25737	26401	29139	29687	32206	32529	28869	29534	25928	25167	23792	24732	25737	26401	29139	29687	32206	32529	28869	29534	25928	25167
Balance	m3	-15031	-13307	-12185	-8104	-6409	-5268	-5914	-6351	-7692	-10136	-11556	-13858	-15031	-13307	-12185	-8104	-6409	-5268	-5914	-6351	-7692	-10136	-11556	-13858	-15589	-13811	-12743	-8643	-6967
Cumulative	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932
Capacity including all dredge ponds	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932

Yannathan water balance - Wet scenario

Assumptions:
clay perimeter bunds effectively preclude lateral inflow and outflow
27 Dust suppression from Dec-Mar inclusive (25 days/month)in m3/day
19.5 Licence allocation (ML)

Rainfall increased by 10%
Evaporation decreased by 5%

		Stage 19																												
		Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25
Rainfall (ave)	mm	63	52	60	80	89	94	91	102	98	94	86	81	63	52	60	80	89	94	91	102	98	94	86	81	63	52	60	80	89
Evaporation (ave)	mm	153	125	99	59	32	20	24	43	67	104	126	147	153	125	99	59	32	20	24	43	67	104	126	147	153	125	99	59	32
Rainfall to dams	m3	3315	2728	3152	4188	4701	4958	4767	5393	5161	4970	4526	4250	3315	2728	3152	4188	4701	4958	4767	5393	5161	4970	4526	4250	3315	2728	3152	4188	4701
inflow to dry excavation	m3	12123	10949	12123	11732	12123	11732	12123	12123	11732	12123	11732	12123	12123	10949	12123	11732	12123	11732	12123	12123	11732	12123	11732	12123	10795	9750	10795	10446	10795
inflow from base	m3	2361	2133	2361	2285	2361	2285	2361	2361	2285	2361	2285	2361	2361	2133	2361	2285	2361	2285	2361	2361	2285	2361	2285	2361	3132	2829	3132	3031	3132
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	17799	15810	17636	18205	19185	18975	19251	19877	19178	19454	18542	18734	17799	15810	17636	18205	19185	18975	19251	19877	19178	19454	18542	18734	17241	15306	17078	17665	18627
Evaporation from dams	m3	8053	6577	5208	3090	1700	1061	1287	2243	3539	5474	6661	7747	8053	6577	5208	3090	1700	1061	1287	2243	3539	5474	6661	7747	8053	6577	5208	3090	1700
outflow from water storage	m3	21752	19647	21752	21050	21752	21050	21752	21752	21050	21752	21050	21752	21752	19647	21752	21050	21752	21050	21752	21752	21050	21752	21050	21752	21752	19647	21752	21050	21752
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0
TOTAL OUTFLOWS	m3	32105	28523	29260	25765	25077	23737	24664	25619	26214	28851	29336	31798	32105	28523	29260	25765	25077	23737	24664	25619	26214	28851	29336	31798	32105	28523	29260	25765	25077
Balance	m3	-14306	-12713	-11624	-7560	-5892	-4761	-5413	-5743	-7037	-9396	-10794	-13064	-14306	-12713	-11624	-7560	-5892	-4761	-5413	-5743	-7037	-9396	-10794	-13064	-14864	-13217	-12182	-8100	-6450
Cumulative	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932
Capacity including all dredge ponds	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932

Yannathan water balance - Average rainfall

		Stage 20																												
		Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27
Rainfall (ave)	mm	86	82	93	89	86	78	73	57	47	54	72	81	86	82	93	89	86	78	73	57	47	54	72	81	86	82	93	89	86
Morton Evaporation (ave)	mm	21	26	45	71	109	133	155	161	131	104	62	34	21	26	45	71	109	133	155	161	131	104	62	34	21	26	45	71	109
Rainfall to dams	m3	4508	4334	4902	4692	4518	4114	3864	3013	2480	2866	3808	4273	4508	4334	4902	4692	4518	4114	3864	4700	3868	4470	5939	6666	7031	6760	7647	7318	7048
inflow to dry excavation	m3	10446	10795	10795	10446	10795	10446	10795	10795	9750	10795	10446	10795	10446	10795	10795	10446	10795	10446	10795	8635	7799	8635	8356	8635	8356	8635	8635	8356	8635
inflow from base	m3	3031	3132	3132	3031	3132	3031	3132	3132	2829	3132	3031	3132	3031	3132	3132	3031	3132	3031	3132	1597	1443	1597	1546	1597	1546	1597	1597	1546	1597
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	17985	18260	18828	18169	18444	17591	17790	16940	15058	16792	17284	18200	17985	18260	18828	18169	18444	17591	17790	14933	13110	14702	15841	16898	16933	16992	17879	17220	17280
Evaporation from dams	m3	1117	1355	2361	3725	5762	7012	8154	8477	6923	5483	3253	1790	1117	1355	2361	3725	5762	7012	8154	13222	10798	8552	5073	2792	1743	2113	3682	5811	8987
outflow from water storage	m3	21050	21752	21752	21050	21752	21050	21752	21752	19647	21752	21050	21752	21050	21752	21752	21050	21752	21050	21752	27166	24537	27166	26290	27166	26290	27166	27166	26290	27166
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0
TOTAL OUTFLOWS	m3	23792	24732	25737	26401	29139	29687	32206	32529	28869	29534	25928	25167	23792	24732	25737	26401	29139	29687	32206	42689	37635	38018	32988	31583	29658	30904	32473	33726	37778
Balance	m3	-5808	-6472	-6909	-8232	-10694	-12096	-14416	-15589	-13811	-12743	-8643	-6967	-5808	-6472	-6909	-8232	-10694	-12096	-14416	-27756	-24525	-23316	-17147	-14685	-12724	-13912	-14594	-16505	-20498
Cumulative	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198

		Stage 20																												
		Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26	Feb-26	Mar-26	Apr-26	May-26	Jun-26	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27
Rainfall (ave)	mm	94	91	102	98	94	86	81	63	52	60	80	89	94	91	102	98	94	86	81	63	52	60	80	89	94	91	102	98	94
Evaporation (ave)	mm	20	24	43	67	104	126	147	153	125	99	59	32	20	24	43	67	104	126	147	153	125	99	59	32	20	24	43	67	104
Rainfall to dams	m3	4958	4767	5393	5161	4970	4526	4250	3315	2728	3152	4188	4701	4958	4767	5393	5161	4970	4526	4250	5170	4255	4917	6533	7332	7734	7436	8411	8050	7752
inflow to dry excavation	m3	10446	10795	10795	10446	10795	10446	10795	10795	9750	10795	10446	10795	10446	10795	10795	10446	10795	10446	10795	8635	7799	8635	8356	8635	8356	8635	8635	8356	8635
inflow from base	m3	3031	3132	3132	3031	3132	3031	3132	3132	2829	3132	3031	3132	3031	3132	3132	3031	3132	3031	3132	1597	1443	1597	1546	1597	1546	1597	1597	1546	1597
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	18435	18693	19319	18638	18896	18002	18176	17241	15306	17078	17665	18627	18435	18693	19319	18638	18896	18002	18176	15403	13497	15149	16435	17564	17636	17668	18644	17952	17985
Evaporation from dams	m3	1061	1287	2243	3539	5474	6661	7747	8053	6577	5208	3090	1700	1061	1287	2243	3539	5474	6661	7747	12561	10258	8124	4820	2652	1656	2008	3498	5520	8538
outflow from water storage	m3	21050	21752	21752	21050	21752	21050	21752	21752	19647	21752	21050	21752	21050	21752	21752	21050	21752	21050	21752	27166	24537	27166	26290	27166	26290	27166	27166	26290	27166
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0
TOTAL OUTFLOWS	m3	23737	24664	25619	26214	28851	29336	31798	32105	28523	29260	25765	25077	23737	24664	25619	26214	28851	29336	31798	42027	37095	37590	32735	31443	29570	30799	32289	33435	37329
Balance	m3	-5301	-5971	-6301	-7576	-9954	-11334	-13622	-14864	-13217	-12182	-8100	-6450	-5301	-5971	-6301	-7576	-9954	-11334	-13622	-26625	-23598	-22441	-16300	-13879	-11934	-13131	-13646	-15483	-19344
Cumulative	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	644932	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198

Yannathan water balance - Average rainfall

Yannathan water balance - Averag

		Stage 21													
		Nov-27	Dec-27	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28
Rainfall (ave)	mm	78	73	57	47	54	72	81	86	82	93	89	86	78	73
Morton Evaporation (ave)	mm	133	155	161	131	104	62	34	21	26	45	71	109	133	155
Rainfall to dams	m3	6417	6027	4700	3868	4470	5939	6666	7031	6760	7647	7318	7048	6417	6027
inflow to dry excavation	m3	8356	8635	7799	8635	8356	8635	8356	8635	8635	8356	8635	8356	8635	7799
inflow from base	m3	1546	1597	1597	1443	1597	1546	1597	1546	1597	1597	1546	1597	1546	1597
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	16319	16259	14097	13946	14424	16120	16619	17212	16992	17600	17499	17001	16598	15423
Evaporation from dams	m3	10937	12719	13222	10798	8552	5073	2792	1743	2113	3682	5811	8987	10937	12719
outflow from water storage	m3	26290	27166	27166	24537	27166	26290	27166	26290	27166	27166	26290	27166	26290	27166
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	0	675	675	675	675	0	0	0	0	0	0	0	0	675
TOTAL OUTFLOWS	m3	38852	42185	42689	37635	38018	32988	31583	29658	30904	32473	33726	37778	38852	42185
Balance	m3	-22532	-25926	-28592	-23689	-23594	-16869	-14964	-12446	-13912	-14873	-16227	-20777	-22254	-26762
Cumulative	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198

		Stage 22														
		Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29	Jan-30	Feb-30	Mar-30
Rainfall (ave)	mm	57	47	54	72	81	86	82	93	89	86	78	73	57	47	54
Morton Evaporation (ave)	mm	161	131	104	62	34	21	26	45	71	109	133	155	161	131	104
Rainfall to dams	m3	12536	10317	11921	15839	17777	18752	18028	20394	19518	18796	17115	16073	12536	10317	11921
inflow to dry excavation	m3	8635	7799	8635	8356	8635	8356	8635	8635	8356	8635	8356	8635	8635	7799	8635
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	32807	29632	32807	31749	32807	31749	32807	32807	31749	32807	31749	32807	32807	29632	32807
TOTAL INFLOWS	m3	53978	47748	53363	55944	59220	58857	59470	61836	59623	60239	57220	57515	53978	47748	53363
Evaporation from dams	m3	35264	28798	22807	13531	7445	4648	5636	9820	15497	23969	29169	33922	35264	28798	22807
outflow from water storage	m3	-27166	-24537	-27166	-26290	-27166	-26290	-27166	-27166	-26290	-27166	-26290	-27166	-27166	-24537	-27166
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675
TOTAL OUTFLOWS	m3	10398	6561	-2059	-11134	-18096	-20017	-19905	-15721	-9167	-1572	4504	9056	10398	6561	-2059
Balance	m3	43580	41187	55422	67078	77315	78874	79375	77557	68790	61811	52716	48459	43580	41187	55422
Cumulative	m3	43580	84767	140189	207268	284583	363457	442833	520390	589180	650991	703707	752167	795747	836934	892356
Capacity	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023

		Stage 21													
		Nov-27	Dec-27	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28	Jul-28	Aug-28	Sep-28	Oct-28	Nov-28	Dec-28
Rainfall (ave)	mm	86	81	63	52	60	80	89	94	91	102	98	94	86	81
Evaporation (ave)	mm	126	147	153	125	99	59	32	20	24	43	67	104	126	147
Rainfall to dams	m3	7059	6629	5170	4255	4917	6533	7332	7734	7436	8411	8050	7752	7059	6629
inflow to dry excavation	m3	8356	8635	7799	8635	8356	8635	8356	8635	8635	8356	8635	8356	8635	7799
inflow from base	m3	1546	1597	1597	1443	1597	1546	1597	1546	1597	1597	1546	1597	1546	1597
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	16961	16861	14567	14333	14871	16714	17286	17915	17668	18365	18231	17706	17240	16026
Evaporation from dams	m3	10390	12083	12561	10258	8124	4820	2652	1656	2008	3498	5520	8538	10390	12083
outflow from water storage	m3	26290	27166	27166	24537	27166	26290	27166	26290	27166	27166	26290	27166	26290	27166
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	0	675	675	675	675	0	0	0	0	0	0	0	0	675
TOTAL OUTFLOWS	m3	38305	41549	42027	37095	37590	32735	31443	29570	30799	32289	33435	37329	38305	41549
Balance	m3	-21344	-24688	-27460	-22762	-22720	-16021	-14157	-11655	-13131	-13924	-15204	-19623	-21065	-25523
Cumulative	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capacity	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198

		Stage 22														
		Jan-29	Feb-29	Mar-29	Apr-29	May-29	Jun-29	Jul-29	Aug-29	Sep-29	Oct-29	Nov-29	Dec-29	Jan-30	Feb-30	Mar-30
Rainfall (ave)	mm	63	52	60	80	89	94	91	102	98	94	86	81	63	52	60
Evaporation (ave)	mm	153	125	99	59	32	20	24	43	67	104	126	147	153	125	99
Rainfall to dams	m3	13790	11348	13113	17423	19555	20627	19831	22433	21470	20676	18826	17680	13790	11348	13113
inflow to dry excavation	m3	8635	7799	8635	8356	8635	8356	8635	8635	8356	8635	8356	8635	8635	7799	8635
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	32807	29632	32807	31749	32807	31749	32807	32807	31749	32807	31749	32807	32807	29632	32807
TOTAL INFLOWS	m3	55232	48780	54555	57528	60997	60733	61273	63875	61575	62118	58931	59122	55232	48780	54555
Evaporation from dams	m3	33501	27358	21667	12855	7073	4415	5354	9329	14723	22771	27710	32226	33501	27358	21667
outflow from water storage	m3	-27166	-24537	-27166	-26290	-27166	-26290	-27166	-27166	-26290	-27166	-26290	-27166	-27166	-24537	-27166
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675
TOTAL OUTFLOWS	m3	8635	5121	-3199	-11810	-18468	-20249	-20187	-16212	-9942	-2771	3045	7360	8635	5121	-3199
Balance	m3	46597	43659	57755	69339	79465	80982	81460	80087	71517	64889	55886	51763	46597	43659	57755
Cumulative	m3	46597	90256	148010	217349	296814	377796	459256	539344	610861	675750	731636	783398	829995	873654	931409
Capacity	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023

e rainfall

Yannathan water balance - Average rainfall

		Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32
											Stage 23																			
Rainfall (ave)	mm	72	81	86	82	93	89	86	78	73	57	47	54	72	81	86	82	93	89	86	78	73	57	47	54	72	81	86	82	93
Morton Evaporation (ave)	mm	62	34	21	26	45	71	109	133	155	161	131	104	62	34	21	26	45	71	109	133	155	161	131	104	62	34	21	26	45
Rainfall to dams	m3	15839	17777	18752	18028	20394	19518	18796	17115	16073	16668	13717	15850	21060	23637	24933	23970	27115	25951	24992	22756	21371	16668	13717	15850	21060	23637	24933	23970	27115
inflow to dry excavation	m3	8356	8635	8356	8635	8635	8356	8635	8356	8635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	31749	32807	31749	32807	32807	31749	32807	31749	32807	38392	34677	38392	37153	38392	37153	38392	38392	37153	38392	37153	38392	38392	34677	38392	37153	38392	37153	38392	38392
TOTAL INFLOWS	m3	55944	59220	58857	59470	61836	59623	60239	57220	57515	55060	48393	54242	58213	62029	62086	62362	65507	63104	63384	59909	59762	55060	48393	54242	58213	62029	62086	62362	65507
Evaporation from dams	m3	13531	7445	4648	5636	9820	15497	23969	29169	33922	46888	38290	30325	17991	9900	6180	7493	13057	20606	31869	38783	45103	46888	38290	30325	17991	9900	6180	7493	13057
outflow from water storage	m3	-26290	-27166	-26290	-27166	-27166	-26290	-27166	-26290	-27166	35861	32391	35861	34704	35861	34704	35861	35861	34704	35861	34704	35861	35861	32391	35861	34704	35861	34704	35861	35861
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0
TOTAL OUTFLOWS	m3	-11134	-18096	-20017	-19905	-15721	-9167	-1572	4504	9056	85049	72981	68486	54320	47386	42509	44979	50543	56935	69355	75112	83264	85049	72981	68486	54320	47386	42509	44979	50543
Balance	m3	67078	77315	78874	79375	77557	68790	61811	52716	48459	-29989	-24587	-14244	3893	14643	19577	17382	14965	6170	-5972	-15203	-23501	-29989	-24587	-14244	3893	14643	19577	17382	14965
Cumulative	m3	959434	1036750	1115624	1195000	1272557	1341347	1403158	1455874	1504333	1474344	1449757	1435514	1439407	1454050	1473627	1491009	1505974	1512144	1506172	1490969	1467467	1437479	1412891	1398648	1402541	1417184	1436761	1454144	1469108
Capacity	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348

		Apr-30	May-30	Jun-30	Jul-30	Aug-30	Sep-30	Oct-30	Nov-30	Dec-30	Jan-31	Feb-31	Mar-31	Apr-31	May-31	Jun-31	Jul-31	Aug-31	Sep-31	Oct-31	Nov-31	Dec-31	Jan-32	Feb-32	Mar-32	Apr-32	May-32	Jun-32	Jul-32	Aug-32
											Stage 23																			
Rainfall (ave)	mm	80	89	94	91	102	98	94	86	81	63	52	60	80	89	94	91	102	98	94	86	81	63	52	60	80	89	94	91	102
Evaporation (ave)	mm	59	32	20	24	43	67	104	126	147	153	125	99	59	32	20	24	43	67	104	126	147	153	125	99	59	32	20	24	43
Rainfall to dams	m3	17423	19555	20627	19831	22433	21470	20676	18826	17680	18335	15089	17435	23166	26001	27426	26367	29827	28546	27491	25031	23508	18335	15089	17435	23166	26001	27426	26367	29827
inflow to dry excavation	m3	8356	8635	8356	8635	8635	8356	8635	8356	8635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	31749	32807	31749	32807	32807	31749	32807	31749	32807	38392	34677	38392	37153	38392	37153	38392	38392	37153	38392	37153	38392	38392	34677	38392	37153	38392	37153	38392	38392
TOTAL INFLOWS	m3	57528	60997	60733	61273	63875	61575	62118	58931	59122	56727	49765	55827	60319	64392	64580	64759	68219	65699	65883	62185	61899	56727	49765	55827	60319	64392	64580	64759	68219
Evaporation from dams	m3	12855	7073	4415	5354	9329	14723	22771	27710	32226	44543	36376	28808	17091	9405	5871	7119	12404	19575	30276	36844	42848	44543	36376	28808	17091	9405	5871	7119	12404
outflow from water storage	m3	-26290	-27166	-26290	-27166	-27166	-26290	-27166	-26290	-27166	35861	32391	35861	34704	35861	34704	35861	35861	34704	35861	34704	35861	35861	32391	35861	34704	35861	34704	35861	35861
Processing	m3	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
Dust suppression	m3	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0
TOTAL OUTFLOWS	m3	-11810	-18468	-20249	-20187	-16212	-9942	-2771	3045	7360	82704	71066	66969	53421	46891	42200	44605	49890	55904	67762	73173	81009	82704	71066	66969	53421	46891	42200	44605	49890
Balance	m3	69339	79465	80982	81460	80087	71517	64889	55886	51763	-25978	-21301	-11142	6899	17502	22380	20154	18329	9795	-1879	-10988	-19109	-25978	-21301	-11142	6899	17502	22380	20154	18329
Cumulative	m3	1000748	1080213	1161195	1242655	1322742	1394259	1459148	1515034	1566797	1540819	1519518	1508376	1515274	1532776	1555156	1575310	1593639	1603434	1601555	1590566	1571457	1545480	1524179	1513036	1519935	1537437	1559816	1579970	1598299
Capacity	m3	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198	1028198
Capacity including all dredge ponds	m3	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	4461023	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348	6266348

Yannathan water balance - Average rainfall

		Sep-32	Oct-32	Nov-32	Dec-32	Jan-33	Feb-33	Mar-33	Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33	Jan-34	Feb-34	Mar-34	Apr-34	May-34	Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34	Jan-35
						Stage 24																								
Rainfall (ave)	mm	89	86	78	73	57	47	54	72	81	86	82	93	89	86	78	73	57	47	54	72	81	86	82	93	89	86	78	73	57
Morton Evaporation (ave)	mm	71	109	133	155	161	131	104	62	34	21	26	45	71	109	133	155	161	131	104	62	34	21	26	45	71	109	133	155	161
Rainfall to dams	m3	25951	24992	22756	21371	15677	12901	14908	19807	22231	23450	22545	25503	24408	23506	21402	20100	15677	12901	14908	19807	22231	23450	22545	25503	24408	23506	21402	20100	17689
inflow to dry excavation	m3	0	0	0	0	8132	7345	8132	7869	8132	7869	8132	8132	7869	8132	7869	8132	8132	7345	8132	7869	8132	7869	8132	8132	7869	8132	7869	8132	0
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	37153	38392	37153	38392	28109	25388	28109	27202	28109	27202	28109	28109	27202	28109	27202	28109	28109	25388	28109	27202	28109	27202	28109	28109	27202	28109	27202	28109	0
TOTAL INFLOWS	m3	63104	63384	59909	59762	51917	45635	51148	54879	58472	58521	58785	61743	59479	59746	56474	56340	51917	45635	51148	54879	58472	58521	58785	61743	59479	59746	56474	56340	17689
Evaporation from dams	m3	20606	31869	38783	45103	44099	36013	28521	16921	9311	5812	7048	12280	19380	29974	36477	42421	44099	36013	28521	16921	9311	5812	7048	12280	19380	29974	36477	42421	49761
outflow from water storage	m3	34704	35861	34704	35861	61467	55519	61467	59484	61467	59484	61467	61467	59484	61467	59484	61467	61467	55519	61467	59484	61467	59484	61467	61467	59484	61467	59484	61467	0
Processing	m3	1625	1625	1625	1625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dust suppression	m3	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675
TOTAL OUTFLOWS	m3	56935	69355	75112	83264	106241	92207	90663	76405	70778	65296	68515	73747	78864	91441	95961	104563	106241	92207	90663	76405	70778	65296	68515	73747	78864	91441	95961	104563	50436
Balance	m3	6170	-5972	-15203	-23501	-54324	-46572	-39515	-21527	-12306	-6775	-9730	-12004	-19385	-31695	-39487	-48223	-54324	-46572	-39515	-21527	-12306	-6775	-9730	-12004	-19385	-31695	-39487	-48223	-32746
Cumulative	m3	1475278	1469306	1454103	1430602	1376277	1329705	1290190	1268663	1256357	1249582	1239852	1227848	1208463	1176767	1137280	1089058	1034733	988161	948646	927119	914813	908038	898308	886304	866918	835223	795736	747513	714767
Capacity	m3	1028198	1028198	1028198	1028198	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	5395593
Capacity including all dredge ponds	m3	6266348	6266348	6266348	6266348	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	5395593

		Sep-32	Oct-32	Nov-32	Dec-32	Jan-33	Feb-33	Mar-33	Apr-33	May-33	Jun-33	Jul-33	Aug-33	Sep-33	Oct-33	Nov-33	Dec-33	Jan-34	Feb-34	Mar-34	Apr-34	May-34	Jun-34	Jul-34	Aug-34	Sep-34	Oct-34	Nov-34	Dec-34	Jan-35
						Stage 24																								
Rainfall (ave)	mm	98	94	86	81	63	52	60	80	89	94	91	102	98	94	86	81	63	52	60	80	89	94	91	102	98	94	86	81	63
Evaporation (ave)	mm	67	104	126	147	153	125	99	59	32	20	24	43	67	104	126	147	153	125	99	59	32	20	24	43	67	104	126	147	153
Rainfall to dams	m3	28546	27491	25031	23508	17244	14191	16398	21788	24454	25795	24799	28053	26848	25856	23543	22110	17244	14191	16398	21788	24454	25795	24799	28053	26848	25856	23543	22110	19458
inflow to dry excavation	m3	0	0	0	0	8132	7345	8132	7869	8132	7869	8132	8132	7869	8132	7869	8132	8132	7345	8132	7869	8132	7869	8132	8132	7869	8132	7869	8132	0
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	37153	38392	37153	38392	28109	25388	28109	27202	28109	27202	28109	28109	27202	28109	27202	28109	28109	25388	28109	27202	28109	27202	28109	28109	27202	28109	27202	28109	0
TOTAL INFLOWS	m3	65699	65883	62185	61899	53485	46925	52639	56860	60695	60866	61039	64294	61920	62096	58614	58350	53485	46925	52639	56860	60695	60866	61039	64294	61920	62096	58614	58350	19458
Evaporation from dams	m3	19575	30276	36844	42848	41894	34212	27095	16075	8845	5522	6695	11666	18411	28475	34653	40300	41894	34212	27095	16075	8845	5522	6695	11666	18411	28475	34653	40300	47273
outflow from water storage	m3	34704	35861	34704	35861	61467	55519	61467	59484	61467	59484	61467	61467	59484	61467	59484	61467	61467	55519	61467	59484	61467	59484	61467	61467	59484	61467	59484	61467	0
Processing	m3	1625	1625	1625	1625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dust suppression	m3	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675	675	675	0	0	0	0	0	0	0	0	675	675
TOTAL OUTFLOWS	m3	55904	67762	73173	81009	104036	90406	89237	75559	70312	65006	68163	73133	77895	89942	94137	102442	104036	90406	89237	75559	70312	65006	68163	73133	77895	89942	94137	102442	47948
Balance	m3	9795	-1879	-10988	-19109	-50552	-43481	-36599	-18700	-9618	-4139	-7123	-8840	-15976	-27846	-35523	-44092	-50552	-43481	-36599	-18700	-9618	-4139	-7123	-8840	-15976	-27846	-35523	-44092	-28489
Cumulative	m3	1608094	1606215	1595227	1576118	1525566	1482085	1445486	1426786	1417169	1413029	1405906	1397066	1381091	1353245	1317722	1273630	1223078	1179597	1142998	1124299	1114681	1110542	1103419	1094579	1078603	1050757	1015234	971143	942653
Capacity	m3	1028198	1028198	1028198	1028198	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	3526161	5395593
Capacity including all dredge ponds	m3	6266348	6266348	6266348	6266348	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	6245416	5395593

Yannathan water balance - Average rainfall

		Final										
		Feb-35	Mar-35	Apr-35	May-35	Jun-35	Jul-35	Aug-35	Sep-35	Oct-35	Nov-35	Dec-35
Rainfall (ave)	mm	47	54	72	81	86	82	93	89	86	78	73
Morton Evaporation (ave)	mm	131	104	62	34	21	26	45	71	109	133	155
Rainfall to dams	m3	14558	16822	22350	25085	26461	25439	28777	27541	26523	24150	22680
inflow to dry excavation	m3	0	0	0	0	0	0	0	0	0	0	0
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	14558	16822	22350	25085	26461	25439	28777	27541	26523	24150	22680
Evaporation from dams	m3	40636	32183	19093	10506	6558	7953	13857	21868	33822	41159	47866
outflow from water storage	m3	0	0	0	0	0	0	0	0	0	0	0
Processing	m3	0	0	0	0	0	0	0	0	0	0	0
Dust suppression	m3	675	675	0	0	0	0	0	0	0	0	0
TOTAL OUTFLOWS	m3	41311	32858	19093	10506	6558	7953	13857	21868	33822	41159	47866
Balance	m3	-26754	-16036	3257	14579	19902	17486	14920	5673	-7299	-17009	-25186
Cumulative	m3	688013	671977	675234	689813	709715	727201	742122	747795	740496	723486	698300
Capacity	m3	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593
Capacity including all dredge ponds	m3	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593

		Final										
		Feb-35	Mar-35	Apr-35	May-35	Jun-35	Jul-35	Aug-35	Sep-35	Oct-35	Nov-35	Dec-35
Rainfall (ave)	mm	52	60	80	89	94	91	102	98	94	86	81
Evaporation (ave)	mm	125	99	59	32	20	24	43	67	104	126	147
Rainfall to dams	m3	16013	18504	24585	27594	29107	27983	31655	30295	29175	26565	24948
inflow to dry excavation	m3	0	0	0	0	0	0	0	0	0	0	0
inflow from base	m3	0	0	0	0	0	0	0	0	0	0	0
inflow to dredged areas	m3	0	0	0	0	0	0	0	0	0	0	0
TOTAL INFLOWS	m3	16013	18504	24585	27594	29107	27983	31655	30295	29175	26565	24948
Evaporation from dams	m3	38605	30574	18139	9981	6230	7555	13164	20775	32131	39101	45473
outflow from water storage	m3	0	0	0	0	0	0	0	0	0	0	0
Processing	m3	0	0	0	0	0	0	0	0	0	0	0
Dust suppression	m3	675	675	0	0	0	0	0	0	0	0	0
TOTAL OUTFLOWS	m3	39280	31249	18139	9981	6230	7555	13164	20775	32131	39101	45473
Balance	m3	-23266	-12745	6447	17613	22876	20428	18491	9520	-2956	-12536	-20525
Cumulative	m3	919387	906642	913088	930701	953578	974005	992496	1002017	999061	986525	966000
Capacity	m3	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593
Capacity including all dredge ponds	m3	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593	5395593

Appendix E Risk register

Groundwater Risk Register

Activity	Source	Hazard	Risk Event no	Risk description	Stage	Receptor	Location and proximity	Impact	Evidence inherent risk	Likelihood	Inherent Risk Consequence	Inherent Risk	Controls	Performance standards	Likelihood	Residual Risk Consequence	Residual Risk	Monitoring aspect	Monitoring details
Quarry development	Dewatering	Groundwater level declines	S39Q	Water management activities lowering the watertable beyond the reach of plant roots	Quarrying	Vegetation	Site and surrounds	Decline in groundwater levels	Site inspection records, groundwater level data if available	Possible	Minor	Medium	Monitor vegetation health; Monitor groundwater level; Additional watering; Clay liner on perimeter batters	No impact on vegetation	Unlikely	Minor	Low	Vegetation health, groundwater level	Site inspection, review of monitoring data if available
Quarry development	Dewatering	Groundwater level declines	S58Q	Water management activities creating increased groundwater drawdown	Quarrying	Groundwater users	50m west of western site boundary	Decline in groundwater levels	Monitoring bore data	Possible	Minor	Medium	Monitor groundwater level;	No large drawdown	Unlikely	Minor	Low	Groundwater bores	Groundwater levels
Quarry development	Dewatering	Contamination	S40Q	Water management activities impacting on the watertable and increasing salinity which affects groundwater conditions	Quarrying	Groundwater	Onsite and offsite to the west and northwest	Increased salinity	SW monitoring data	Possible	Minor	Medium	Monitor groundwater quality Monitor pond quality Clay liner on perimeter batters	ERS	Unlikely	Minor	Low	Surface water, groundwater	Water quality sampling and analysis
Quarry development	Dewatering	Contamination	S41Q	Water management activities impacting on the watertable and increasing salinity which affects plant growth	Quarrying	Ecosystems	Onsite waterway	Increased salinity	SW monitoring data	Possible	Moderate	Medium	Monitor pond quality Monitor groundwater quality Monitor vegetation health; Clay liner on perimeter batters	ANZG Ecosystem guidelines, ERS	Unlikely	Minor	Low	Surface water	Surface water sampling and analysis
Quarry development	Dewatering	Surface water discharge	S59Q	Greater groundwater inflow than anticipated necessitating off-site discharge	Quarrying	Surface water	Onsite waterway	Surface water quality	SW monitoring	Rare	Minor	Low	Monitor pond quality Monitor SW quality; Coordinate discharges with high flows; Inspection and maintenance for control structures; Stabilise land around discharge points; Obtain licence for wastewater discharges; Maintain records of discharges;	ERS	Rare	Minor	Low	Water storage ponds	Pond levels
Quarry development	Dewatering	Surface water discharge	S60Q	Greater groundwater inflow than anticipated necessitating off-site discharge	Quarrying	Ecology	Onsite waterway	Declining health	Site inspection records SW monitoring data	Rare	Minor	Low	Monitor vegetation health; Maintain records of discharges; Obtain permits for works on waterways; Obtain licence for wastewater discharges; Inspection and maintenance for control structures; Monitor pond quality Stabilise land around discharge points; Monitor SW quality;	ERS	Rare	Minor	Low	Vegetation health	Site inspection
Processing	Sand washing	Contamination	S21Q	Contamination of groundwater from filtercake during quarrying phase	Quarrying	Groundwater	Onsite	Contamination from filtercake (pH)	GW Monitoring data	Unlikely	Minor	Low	Targeted monitoring;	ERS	Unlikely	Minor	Low	pH	Sampling and analysis of groundwater

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Appendix F Flora and Fauna Assessment

Final Report

Biodiversity Assessment for proposed expansion to the Yannathan Sand Quarry: 870 and 910 Western Port Road, Yannathan, Victoria

Prepared for

Ricardo Energy Environment and Planning

September 2022

Ecology and Heritage Partners Pty Ltd

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DOCUMENT CONTROL

Assessment type	Biodiversity Assessment for proposed expansion to the Yannathan Sand Quarry
Address	870 and 910 Western Port Road, Yannathan, Victoria
Project number	14023
Project manager	Claire Ranyard (Senior Botanist)
Report reviewer	Shannon LeBel (Geelong Resource Manager / Associate Ecologist)
Other EHP staff	Nerissa Crabbe (Botanist); Anneke Martin (Consultant Botanist)
Mapping	Dr Monique Elsley (GIS Coordinator)
File name	14023_EHP_BA_YannathanQuarryExpansion_Final_16092022
Client	Ricardo Energy Environment and Planning
Bioregion	Gippsland Plain
Catchment Management Authority	Port Phillip and Westernport
Council	Cardinia Shire Council

VERSION CONTROL

Report versions	Comments	Comments made by:	Date submitted
Draft	Report sent to client for review	-	23/02/2021
Preliminary Final	Updated impact footprint, reassessment of significant flora and fauna under updated FFG Act, updated Avoid and Minimise statement, updated offset register search statement, and reference updates.	SLB/AM	06/09/2022
Final	Minor grammatical updates. Amended watercourse realignment shown.	SLB	16/09/2022

SUMMARY

Introduction

Ecology and Heritage Partners Pty Ltd was commissioned by Ricardo Energy Environment and Planning to conduct an Ecological Assessment of the proposed extension to the Yannathan Sand Quarry.

This assessment was undertaken to identify and characterise the vegetation on-site, determine the presence (or likelihood thereof) of any significant flora and fauna species and/or ecological communities, and address any implications under Commonwealth and State environmental legislation.

Methods

A field assessment was undertaken on 17 December 2020 to obtain information on terrestrial flora and fauna values within the study area. Vegetation within the study area was assessed according to the habitat hectare methodology, which is described in the Vegetation Quality Assessment Manual.

Results

Flora

Thirty flora species (13 native and 17 non-native) were recorded within the study area during the field assessment. Two flora species listed as protected under the *Flora and Fauna Guarantee Act 1988* were present within the study area. No additional significant flora species were recorded in the study area. Based on the highly modified nature of the study area, historical and ongoing land-uses, landscape context and the proximity of previous records, significant flora species are considered unlikely to occur within the study area due to the absence of suitable habitat and high levels of disturbance.

Fauna

No significant fauna species are considered likely to occur within the study area, due to the lack of suitable habitat features (e.g. wetlands, structurally diverse vegetation, hollow bearing trees), and modified state of the study area through previous removal of vegetation for agricultural use and construction of two large water retention basins.

Communities

Vegetation within the study area did not meet the condition thresholds that define any significant ecological communities.

Removal of native vegetation (the Guidelines)

The naturally established patches of Swampy Riparian Woodland shown on Figure 2 are not included in the impact assessment, due to being classified as 'regrowth' which has naturally established on the land within the last ten years.

The vegetation proposed to be removed is within Location 2, with one Large scattered tree (with an extent of 0.0703 hectares) proposed to be removed. As such, the permit application falls under the Intermediate Assessment pathway.

The offset requirement for native vegetation removal is 0.015 General Habitat Units (HUs) and one Large Tree.

Legislative and Policy Implications

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act - Federal)

No nationally significant values were recorded within the study area or are considered likely to occur, and the proposed action is unlikely to have a significant impact on any matter of NES. As such, a referral to the Commonwealth Environment Minister is not required regarding matters listed under the EPBC Act.

Flora and Fauna Guarantee Act 1988 (FFG Act - Victoria)

Two species listed as protected under the FFG Act were recorded within the study area, Prickly Moses *Acacia verticillata* and Shiny Cassinia *Cassinia longifolia*. A total of two Prickly Moses and approximately 15 Shiny Cassinia are proposed to be removed. The study area occurs within private property, therefore a permit under the FFG Act will not be required for the removal of these species.

Mineral Resources (Sustainable Development) Act 1990 (MRSD Act)

A work plan variation will need to be prepared as the proposed development does not meet any of the exemptions listed under the Act. In order for a Work Plan to be approved, the relevant State Government departments must be satisfied of “all necessary planning consents and approvals” including where Victoria’s native vegetation policy requires action has been addressed.

Planning and Environment Act 1987

The clearing of native vegetation for extractive industries is exempt from the requirement for a planning permit subject to an assessment as part of the work plan approval process.

Other Legislation and Policy

Implications relating to other local and State policy (*Wildlife Act 1975*, *Catchment and Land Protection Act 1994*, local government authorities) as well as additional studies or reporting that may be required (Conservation Management Plan, Weed Management Plan, Construction Environment Managements Plan) are provided in Section 4.

CONTENTS

1 INTRODUCTION

1.1 Background

Ecology and Heritage Partners Pty Ltd was commissioned by Ricardo Energy Environment and Planning on behalf of Hanson Construction Materials Pty Ltd (Hanson)to undertake a Biodiversity Assessment for proposed expansion to the Yannathan Sand Quarry at 870 and 910 Western Port Road, Yannathan, Victoria.

We understand that Hanson plan to extend the sand quarry extraction area boundary beyond the current Work Plan and realign the existing watercourse. As such, the Work Plan Variation requires an updated ecological assessment corresponding to the proposed extraction areas and watercourse.

The purpose of the assessment was to identify the extent and type of native vegetation present within the study area and to determine the presence of significant flora and fauna species and/or ecological communities. This report presents the results of the assessment and discusses the potential ecological and legislative implications associated with the proposed action. The report also provides recommendations to address or reduce impacts and, where necessary, highlights components that require further investigation.

1.2 Study Area

The study area is located in the north western section of 870 and 910 Western Port Road, Yannathan and is approximately 80 kilometres south-east of Melbourne's CBD (Figure 1). The study area covers approximately 23 hectares and is bound by the existing quarry along the southern boundary, Milners Road to the west, Western Port Road to the north, and agricultural land to the east. Past land use within the study area has historically been used for grazing activities and predominantly cleared of native vegetation (Plate 1).

In addition to grazing land, the study area supports four water retention basins, existing buildings, laydown areas, the main access road into the quarry and grazing land (Plate 2). It is generally flat, with no ridges, crests within or immediately adjacent to the site. A minor drainage line is present within the study area, running east to west through the middle of the site, which is proposed to be realigned.

For the purposes of this assessment, the proposed 'extension area' and 'realigned watercourse' areas (as shown in Figure 2) were subject to the on-ground assessment.

According to the Department of Environment, Land, Water and Planning (DELWP) NatureKit Map (DELWP 2022a), the study area is located within the Gippsland Plain bioregion, Port Phillip and Westernport Catchment Management Authority (CMA) and Cardinia Shire Council.

2 METHODS

2.1 Desktop Assessment

Relevant literature, online-resources and databases were reviewed to provide an assessment of flora and fauna values associated with the study area. The following information sources were reviewed:

- The DELWP NatureKit Map (DELWP 2022a) and Native Vegetation Information Management (NVIM) Tool (DELWP 2022b) for:
  - Modelled data for location risk, native vegetation patches, scattered trees and habitat for rare or threatened species; and,
  - The extent of historic and current Ecological Vegetation Classes (EVCs).
- EVC benchmarks (DELWP 2022c) for descriptions of EVCs within the relevant bioregion;
- The Victorian Biodiversity Atlas (VBA) for previously documented flora and fauna records within the project locality (DELWP 2022d);
- The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) Protected Matters Search Tool (PMST) for matters of National Environmental Significance (NES) protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (DCCEEW 2022);
- Relevant listings under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act), including the latest Threatened (DELWP 2022e) and Protected (DELWP 2019) Lists;
- The online VicPlan Map (DELWP 2022f) to ascertain current zoning and environmental overlays in the study area;
- Aerial photography of the study area; and
- Previous ecological assessments relevant to the study area; including;
  - Flora and Fauna Assessment and Net Gain Analysis of the Proposed Expansion of the Hanson Yannathan San Extraction Quarry, Victoria. Ecology and Heritage Partners 2013.

2.2 Field Assessment

A field assessment was undertaken on 17 December 2020 to obtain information on flora and fauna values within the study area. The study area was walked, with all commonly observed vascular flora and fauna species recorded, significant records mapped and the overall condition of vegetation and habitats noted. Ecological Vegetation Classes (EVCs) were determined with reference to DELWP pre-1750 and extant EVC mapping (DELWP 2022a) and their published descriptions (DELWP 2022c).

Plate 1. Previously disturbed agricultural land within the study area.

Plate 2. Water retention dams within the study area.

2.3 Removal, Destruction or Lopping of Native Vegetation (the Guidelines)

The clearing of native vegetation for mining and extractive industries is exempt from the requirement for a planning permit under the *Planning and Environment Act 1987* subject to an assessment as part of the work plan approval process required under the *Mineral Resources (Sustainable Development) Act 1990* (MRSD Act). The removal of native vegetation for the Earth Resources Industry (ERI) is regulated through the Mining and Extractive Industry Work Approvals Process. A Memorandum of Understanding (MoU) between the former DSE and DPI recognises that native vegetation should be offset in accordance with the relevant legislation.

Further information regarding the legislative requirements are provided in Section 4.

2.3.1 Assessment Pathway

The Guidelines manage the impacts on biodiversity from native vegetation removal using an assessment-based approach. Two factors – extent risk and location category – are used to determine the assessment pathway. The location category (1, 2 or 3) has been determined for all areas in Victoria and is available on DELWP's NVIM Tool (DELWP 2022b). Determination of assessment pathway is summarised in Table 1.

Table 1. Assessment pathways for applications to remove, destroy or lop native vegetation (DELWP 2017).

Extent		Location		
		1	2	3
Native Vegetation	Less than 0.5 hectares and not including any large trees	Basic	Intermediate	Detailed
	Less than 0.5 hectares and including one or more large trees	Intermediate	Intermediate	Detailed
	0.5 hectares or more	Detailed	Detailed	Detailed

Notes: For the purpose of determining the assessment pathway of an application to remove native vegetation the extent includes any other native vegetation that was permitted to be removed on the same contiguous parcel of land with the same ownership as the native vegetation to be removed, where the removal occurred in the five year period before an application to remove native vegetation is lodged.

2.3.2 *Vegetation Assessment*

Native vegetation (as defined in Table 2) is assessed using two key parameters: extent (in hectares) and condition. For the purposes of this assessment, both condition and extent were determined as part of the habitat hectare assessment.

Table 2. Determination of a patch of native vegetation (DELWP 2017).

Category	Definition	Extent	Condition
Patch of native vegetation	An area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native; OR An area with three or more native canopy trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy; OR any mapped wetland included in the *Current Wetlands map*, available in DELWP systems and tools.	Measured in hectares. Based on hectare area of the native patch.	Vegetation Quality Assessment Manual (DSE 2004). Modelled condition for *Current Wetlands*.
Scattered tree	A native canopy tree that does not form part of a native patch.	Measured in hectares. Each Large scattered tree is assigned an extent of 0.071 hectares (30m diameter). Each Small scattered tree is assigned a default extent of 0.31 hectares (10 metre diameter)	Scattered trees are assigned a default condition score of 0.2 (outside a patch).

Notes: Native vegetation is defined in the Victoria Planning Provisions as 'plants that are indigenous to Victoria, including trees, shrubs, herbs and grasses'.

2.3.3 *Impact Avoidance and Minimisation*

All applications to remove native vegetation must demonstrate the three-step approach of avoid, minimise and offset. This is a precautionary approach that aims to ensure that the removal of native vegetation is restricted to what is reasonably necessary, and that biodiversity is appropriately compensated for any native vegetation removal that is approved.

2.3.4 *Offsets*

Biodiversity offsets are required to compensate for the permitted removal of native vegetation. Offset obligations and offset site criteria are determined in accordance with the Guidelines (DELWP 2017) and are divided into two categories, being General Habitat Units and Species Habitat Units.

The offset requirements for native vegetation removal are calculated by DELWP and presented in a Native Vegetation Removal (NVR) Report, which are based on the vegetation condition scores determined during the biodiversity assessment.

2.4 Assessment Qualifications and Limitations

This report has been written based on the quality and extent of the ecological values and habitat considered to be present or absent at the time of the desktop and/or field assessments being undertaken.

The 'snapshot' nature of a standard biodiversity assessment meant that migratory, transitory or uncommon fauna species may have been absent from typically occupied habitats at the time of the field assessment. In addition, annual or cryptic flora species such as those that persist via underground tubers may also be absent.

A comprehensive list of all terrestrial flora and fauna present within the study area was not undertaken as this was not the objective of the assessment. Rather a list of commonly observed species was recorded to assist in determining the broader biodiversity values present within the study area.

Ecological values identified within the study area were recorded using a hand-held GPS or tablet with an accuracy of +/-3 metres. This level of accuracy is considered to provide an accurate assessment of the ecological values present within the study area; however, this data should not be used for detailed surveying purposes.

Targeted flora or fauna surveys were not undertaken, as this was beyond the preliminary scope of the project. Nevertheless, the terrestrial flora and fauna data collected during the field assessment and information obtained from relevant desktop sources is considered to adequately inform an accurate assessment of the ecological values present within the study area.

3 RESULTS

3.1 Vegetation Condition

Several patches of native vegetation, regrowth and one scattered native tree were recorded within the study area. The remainder of the study area comprised introduced and planted vegetation, present as pasture grass and screen plantings around buildings and along the property boundary.

A list of all flora species recorded during the field assessment are provided in Appendix 1.1.

3.1.1 *Patches of Native Vegetation*

Native vegetation in the study area is representative of one EVC: Swampy Riparian Woodland (EVC 83). The presence of this EVC is generally consistent with the modelled pre-1750s native vegetation mapping (DELWP 2022a), however the vegetation comprised within the patches has naturally regrown since the previous assessment undertaken in 2013 (Ecology and Heritage Partners 2013). Specific details relating to the observed EVC is provided below.

The results of the habitat hectare assessment are provided in Appendix 1.2.

Swampy Riparian Woodland

Swampy Riparian Woodland (SRW) was recorded within and directly adjacent to the study area, present in varying conditions. A linear strip of SRW was recorded adjacent to the western boundary of the study area, containing several large trees and an understory dominated by Swamp Paperbark *Melaleuca ericifolia* (SRW1, Figure 2). This patch is considered to be remnant

Within the study area, SRW occurred as naturally established (regrowth) vegetation. Previous vegetation mapping of the study area did not record any patches of SRW within the current study area (Ecology and Heritage Partners 2013), which is consistent with the historical imagery for the study area. The patches of SRW mapped in the recent assessment primarily comprised of scattered understory species, such as Shiny Cassinia *Cassinia longifolia*, Prickly Moses *Acacia verticillata,* Prickly Tea-tree *Leptospermum continentale* and Blackwood *Acacia melanoxylon* (SRW2, SRW3, SRW4, SRW5, SRW6, SRW 9, SRW10, SRW11, SRW12, SRW13, Figure 2*),* or patches of Common *Reed Phragmites australis,* Pale Rush *Juncus pallidus* and Tall Spike-rush *Eleocharis sphacelata* (SRW7 [Plate 3]; SRW8 [Plate 4], Figure 2). No patches contained large trees, supporting the conclusion that they have naturally established since the previous assessment was undertaken.

3.1.2 *Large Trees in Patches*

Five Large Trees, comprising four Swamp Gums *Eucalyptus ovata* and one stag, were recorded in the Swampy Riparian Woodland patch located along the western boundary of the study area (Plate 5; Figure 2).

3.1.3 *Scattered Trees*

One scattered tree, a large Swamp Gum, was recorded within the study area (Plate 6; Figure 2).

Plate 3. Patch of Rush establishment along the modified drainage line within the study area.

Plate 4. Patch of Tall Spike-rush establishment along the modified drainage line within the study area.

Plate 5. Large tree in a Swampy Riparian Woodland patch along the western boundary of the study area.

Plate 6. A large scattered Swamp Gum present in the north western corner of the study area.

3.1.4 Introduced and Planted Vegetation

Areas not supporting native vegetation had a high cover (>95%) of exotic grass species, dominated by environmental weeds such as Rye-grass *Lolium* spp., Sweet Vernal-grass *Anthoxanthum odoratum*, Yorkshire Fog *Holcus lanatus*, Brown-top Bent *Agrostis capillaris* and Prairie Grass *Bromus catharticus*.

Planted species occurred throughout the study area, with a selection of mixed native shrub species planted around the site office, containing Black Sheoak *Allocasuarina littoralis*, Prickly Tea-tree, Swamp Paperbark *Melaleuca ericifolia* and Blackwood. The location of planted vegetation is shown on Figure 2, which is mainly located on bund walls surrounding the outer edge of the western and northern side of the current study area (Plate 7).

Noxious weeds were present within the study area, with Blackberry *Rubus fruticosus* spp. agg. mainly located along the dam fringes and Spear Thistle *Cirsium vulgare* present in limited numbers within the study area's southern half (Plate 8; Figure 2). Blackberry is also a Weed of National Significance (WoNS).

Plate 7. A row of planted trees along the study area's western boundary.

Plate 8. A noxious weed, Spear Thistle, present along the dam edge within the study area.

3.2 Fauna Habitat

Most of the study area consisted of paddocks and existing dams, which contained improved exotic pastures, likely to be used as a foraging resource by common generalist bird species that are tolerant of modified open areas. Fauna observed using this habitat included; Pacific Black Duck *Anas superciliosa*, Australian Magpie *Cracticus tibicen*, Common Blackbird *Turdus merula*, Welcome Swallow *Hirundo neoxenica* and Eastern Banjo Frog *Limnodynastes dumerilii.*

It should be noted that since the assessment was undertaken, the two dams present within the proposed extension area have been removed as per a directive from Earth Resources Regulations (ERR), and aquatic habitat is no longer present.

3.3 Removal, Destruction or Lopping of Native Vegetation (the Guidelines)

The below clearing scenario is based on the removal of native vegetation present within the current study area, as provided by Ricardo Energy Environment and Planning on 25 August 2022 (Figure 2). The naturally established patches of Swampy Riparian Woodland shown on Figure 2 are not included in the below assessment due to being classified as regrowth which has naturally established on the land within the last ten years (See Section 4.3.2 for further details). This includes 0.73 hectares of naturally established Swampy Riparian Woodland within the proposed extension area.

3.3.1 Vegetation proposed to be removed

The study area is within Location 2, with 0.0703 hectares of native vegetation proposed to be removed (Figure 2). As such, the permit application falls under the Intermediate assessment pathway (Table 3).

Table 3. Removal of Native Vegetation (the Guidelines) (DELWP 2017).

Assessment pathway	Intermediate
Location Category	2
Total Extent (past and proposed) (ha)	0.0703
Extent of past removal (ha)	0.00
Extent of proposed removal (ha)	0.0703
Large Trees (scattered and in patches) to be removed (no.)	1
EVC Conservation Status of vegetation to be removed	Endangered (Swampy Riparian Woodland)

3.3.2 Offset Targets

The offset requirement for native vegetation removal is 0.015 General Habitat Units and 1 Large Tree.

A summary of proposed vegetation losses and associated offset requirements is presented in Table 4 and the Native Vegetation Removal (NVR) report is presented in Appendix 3.

Table 4. Offset Targets.

General Offsets Required	0.015 General Habitat Units
Large Trees	1
Vicinity (catchment/council)	Port Phillip and Westernport CMA / Cardinia Shire Council
Minimum Strategic Biodiversity Value*	0.352

*The minimum Strategic Biodiversity Value is 80% of the weighted average score across habitat zones where a General offset is required.

3.4 Significance Assessment

3.4.1 Flora

The VBA contains records of one nationally significant and nine State significant flora species previously recorded within 10 kilometres of the study area (DELWP 2022d) (Figure 3). The PMST nominated 12 additional nationally significant species which have not been previously recorded but have the potential to occur in the locality (DCCEEW 2022) (Appendix 1.4).

No national or State significant flora were recorded during the site assessment, and based on the highly modified and disturbed condition of the study area, landscape context and the proximity of previous records, significant flora species are considered unlikely to occur within the study area due to the and high levels of disturbance through past agricultural activities (e.g. pasture paddocks), construction of two large water retention dams and absence of suitable habitat.

3.4.2 Fauna

The VBA contains records of 11 nationally significant and 12 State significant fauna species previously recorded within 10 kilometres of the study area (DELWP 2022d) (Figure 4). The PMST nominated an additional 19 nationally significant species which have not been previously recorded but have the potential to occur in the locality (DCCEEW 2022) (Appendix 2.1).

There are 155 previous records of Southern Brown Bandicoot *Isoodon obesulus* within 10 kilometres of the study area (Figure 4; Appendix 2.1). The habitat preferences of Southern Brown Bandicoot are relatively broad, with the species known to occur in a variety of habitats, including seemingly disturbed areas dominated by exotic species (e.g. Blackberry *Rubus* spp.) (Maclagan *et al.* 2018).

However, the vegetation within the proposed extraction extension footprint did not contain any of the preferred habitat characteristics of Southern Brown Bandicoot, with a lack of structural vegetation (e.g. shrubs or large tussocks). Further, the study area is relatively isolated from nearby habitat corridors. As a result, Southern Brown Bandicoot are considered unlikely to occur within the expansion footprint or use the vegetation within the extraction footprint as a habitat corridor to traverse between other habitats. Linear corridors of vegetation are present surrounding the study area within the road reserves of Milners Road and Burt Road, however no impacts are proposed to these areas.

The nearby past Southern Brown Bandicoot records are largely confined to Adams Creek Nature Conservation Reserve, which is a large bushland reserve located approximately six kilometres south of the study area (Figure 4).

Based on the modified nature of the study area, the removal of the dams (as per an ERR directive), landscape context and the proximity of previous records, additional significant fauna species are considered unlikely to rely on habitat within the study area for foraging or breeding purposes due to the lack of suitable and/or important habitat features (e.g. large, hollow bearing trees).

3.4.3 Ecological Communities

No national or State-significant communities are present within the study area.

4 LEGISLATIVE AND POLICY IMPLICATIONS

4.1 *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) establishes a Commonwealth process for the assessment of proposed actions likely to have a significant impact on any matters of National Environment Significance (NES), described in Table 5.

Table 5. Potential impacts to matters of National Environmental Significance (NES)

Matter of NES	Potential Impacts
World Heritage properties	The proposed action will not impact any properties listed for World Heritage.
National heritage places	The proposed action will not impact any places listed for national heritage.
Ramsar wetlands of international significance	The study area occurs upstream of one Ramsar wetland (DCCEEW 2022): Westernport Ramsar site (10 – 15 kms) Provided management practices and construction techniques are consistent with Construction Techniques for Sediment Pollution Control (EPA 1991) and Environmental Guidelines for Major Construction Sites (EPA 1996), the proposed action is highly unlikely to impact the ecological character of any Ramsar wetland.
Threatened species and ecological communities	No nationally significant flora species were recorded within the study area.
Migratory and marine species	There is no marine habitat within the study area. Further, the study area would not be classed as an 'important habitat' as defined under the EPBC Act Policy Statement 1.1 Principal Significant Impact Guidelines (DoE 2013), in that it does not contain: • Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species; • Habitat utilised by a migratory species which is at the limit of the species range; or, • Habitat within an area where the species is declining.
Commonwealth marine area	The proposed action will not impact any Commonwealth marine areas.
Nuclear actions (including uranium mining)	The proposed action is not a nuclear action.
Great Barrier Reef Marine Park	The proposed action will not impact the Great Barrier Reef Marine Park.
Water resources impacted by coal seam gas or mining development	The proposed action is not a coal seam gas or mining development.

4.1.1 *Implications*

No nationally significant values were recorded within the study area or are considered likely to occur, and the proposed action is highly unlikely to have a significant impact on any matter of NES. As such, a referral to the Commonwealth Environment Minister is not required regarding matters listed under the EPBC Act.

4.2 *Flora and Fauna Guarantee Act 1988* (Victoria)

The FFG Act is the primary legislation dealing with biodiversity conservation and sustainable use of native flora and fauna in Victoria. Proponents are required to apply for an FFG Act Permit to 'take' listed and/or protected flora species, listed vegetation communities and listed fish species in areas of public land (i.e. within road reserves, drainage lines and public reserves). An FFG Act permit is generally not required for removal of species or communities on private land, or for the removal of habitat for a listed terrestrial fauna species.

No species listed under the FFG Act were recorded within the study area during the field assessment. The following threatening processes listed under the FFG Act should be considered in relation to the proposed development:

- Invasion of native vegetation by 'environmental weeds'.
- Alteration to the natural flow regimes of rivers and streams.

4.2.1 Implications

Two species listed as protected under the FFG Act were recorded within the study area, Prickly Moses and Shiny Cassinia. A total of two Prickly Moses and approximately 15 Shiny Cassinia are proposed to be removed. The study area occurs within private property, therefore a permit under the FFG Act will not be required for the removal of these species.

4.3 *Planning and Environment Act 1987* (Victoria)

The *Planning and Environment Act 1987* outlines the legislative framework for planning in Victoria and for the development and administration of planning schemes. All planning schemes contain native vegetation provisions at Clause 52.17 which require a planning permit from the relevant local Council to remove, destroy or lop native vegetation on a site of more than 0.4 ha, unless an exemption under Clause 52.17-7 of the Victorian Planning Schemes applies.

Importantly, under the exemptions outlined in Clause 52.17-7 of the Cardinia Shire Planning Scheme, a permit is not required where native vegetation that is to be removed, destroyed or lopped to the minimum extent necessary to enable the carrying out of extractive industry in accordance with a work plan approved under the *Mineral Resources (Sustainable Development) Act 1990* and authorised by a work authority under that Act.

4.3.1 Local Planning Scheme

The study area is located within the Cardinia Shire Council. The study area is zoned Green Wedge Zone 1 (GWZ 1) and is covered by a Significant Landscape Overlay – Schedule 3 (SLO3) (DELWP 2022f).

4.3.2 Implications

Extractive Industry

The clearing of native vegetation for mining and extractive industries is exempt from the requirement for a planning permit subject under the 'Stone Extraction' exemption detailed in Clause 52.17-7 of the Cardinia Shire Planning Scheme subject to an assessment as part of the work plan approval process (MRSD Act).

Regrowth

No permit is required to remove, destroy or lop native vegetation that has naturally established or regenerated on land lawfully cleared of naturally established native vegetation, and is less than 10 years old.

The native vegetation within the current proposed extraction footprint was previously assessed in 2013, which did not record any patches of Swampy Riparian Woodland at the time. The initial vegetation clearing of the property occurred prior to 1995 (when Hanson purchased the land), with the previous land use as agriculture, and the vegetation with the study area maintained as cleared land through regular slashing (pers. comm. Yannathan Quarry Manager).

Based upon the vegetation mapping completed in 2013 (Ecology and Heritage Partners 2013), historical land use of the study area and a review of the aerial imagery, it is considered that the SRW patches within the 'extension area' have naturally regenerated on land lawfully cleared of naturally established native vegetation, and is less than 10 years old, and therefore meets the definition of 'regrowth' as per Clause 52.17-7 of the Cardinia Shire planning scheme. As such, these areas have been excluded from the native vegetation impact assessment detailed in Section 3.3.

Significant Landscape Overlay – Schedule 3

No permit under the SLO is required for vegetation that is to be removed, destroyed or lopped to the minimum extent necessary to enable the carrying out of extractive industry in accordance with a work plan approved under the *Mineral Resources (Sustainable Development) Act 1990* and authorised by a work authority granted under that Act.

4.4 *Mineral Resources (Sustainable Development) Act 1990* (Victoria)

Mineral exploration and mining in Victoria are regulated under the *Mineral Resources (Sustainable Development) Act 1990* (MRSD Act). The purpose of this Act is to encourage an economically viable mining industry that operates in a way that is compatible with the environmental, social and economic objectives of the State.

One of the key objectives of this legislation is to establish a legal framework to ensure that mineral resources are developed in ways that minimise the impacts on the environment. The Act requires that a licensee proposing to work under a mining licence submit a Work Plan.

Section 79 of the Act requires that the Work Plan includes a 'Rehabilitation Plan' for the progressive rehabilitation of land disturbed by the project.

The 'Mineral Resources (Sustainable Development) (Mineral Industries) Regulations 2019' require that, as of 1 July 2020, the Rehabilitation Plan component of the draft mining Work Plan must include the proposed land uses after rehabilitation, which must consider the community views expressed during consultation.

The Regulations also require that the draft mining Work Plan must include an identification and assessment of the risks that may require monitoring, maintenance, treatment or other ongoing land management activities after rehabilitation is complete, in relation to the environment, any member of the public, or land, property or infrastructure in the vicinity of the rehabilitated land.

4.4.1 *Implications*

In order for a Work Plan to be approved, DELWP and the Department of Jobs, Precincts and Regions (DJPR) must be satisfied of "all necessary planning consents and approvals" including where Victoria's native vegetation policy requires action, has been addressed (DPI 2009).

4.4.2 *The Guidelines*

The State Planning Policy Framework and the decision guidelines at Clause 12.01 Biodiversity and Clause 52.17 Native Vegetation require Planning and Responsible Authorities to have regard for the Guidelines (DELWP 2017).

The vegetation proposed to be removed is within Location 2, with one Large scattered tree (with an extent of 0.0703 hectares) proposed to be removed. As such, the permit application falls under the Intermediate Assessment pathway.

The offset requirement for native vegetation removal is 0.015 General Habitat Units (HUs) and one Large Tree.

4.5 *Catchment and Land Protection Act 1994* (Victoria)

Two weeds listed as noxious under the *Catchment and Land Protection Act 1994* was recorded during the assessment, Blackberry and Spear Thistle (Figure 2). Similarly, there is evidence that the study area is currently occupied by several pest fauna species listed under the CaLP Act, European Rabbit *Oryctolagus cuniculus*, Red Fox *Vulpes vulpes*. Listed noxious weeds/pests should be appropriately controlled throughout the study area.

4.6 *Wildlife Act 1975* and Wildlife Regulations 2013 (Victoria)

The *Wildlife Act 1975* (and associated Wildlife Regulations 2013) is the primary legislation in Victoria providing for protection and management of wildlife. Authorisation for habitat removal may be obtained under the *Wildlife Act 1975* through a licence granted under the *Forests Act 1958*, or under any other Act such as the *Planning and Environment Act 1987*. Any persons engaged to remove, salvage, hold or relocate native fauna during construction must hold a current Management Authorisation under the *Wildlife Act 1975*, issued by DELWP.

5 MITIGATION MEASURES

5.1 Avoid and Minimise Statement

The study area has not been subject to a strategic level planning process for the purposes of detailing native vegetation removal. However, the study area is within covered by the Cardinia Western Port green Wedge Management Plan (Cardinia Shire Council 2017).

It is not possible to avoid impacts to native vegetation without undermining the requirements of the project. Due to the nature of the proposed development (extractive industry) and the location of the resource in the ground, the extraction footprint is proposed to extend north from the existing extraction pit.

The extent of native vegetation within the study area is minimal, and predominately comprises of low quality vegetation which has re-established over the past ten years. One large native scattered tree is located in the north western corner. When identified during the site assessment, the tree was observed partially lying down, likely to have fallen during strong winds over the previous years, although still appeared to be surviving (Section 3.1.3, Plate 5).

In the context of the development, the modified condition of ecological values proposed to be impacted, and the extent of native vegetation proposed to be retained and enhanced within the study area, it is considered that the minimisation measures implemented are appropriate in this instance.

No feasible opportunities exist to further avoid or minimise impacts on native vegetation without undermining the key objectives of the proposal

5.2 Best Practice Mitigation Measures

Recommended measures to mitigate impacts upon terrestrial and aquatic values present within the study area may include:

- Ensuring any proposed works remain within the intended extraction (and greater development) footprint, i.e. not disturbing or removing areas of native vegetation outside the proposed works area. This also applies to machinery storage, materials stockpiles, personnel rest areas and access roads;
- Minimise impacts to native vegetation and habitats through construction and micro-siting techniques, including fencing retained areas of native vegetation. If indeed necessary, trees should be lopped or trimmed rather than removed. Similarly, soil disturbance and sedimentation within wetlands should be avoided or kept to a minimum, to avoid, or minimise impacts to fauna habitats;
- All contractors should be aware of ecologically sensitive areas to minimise the likelihood of inadvertent disturbance to areas marked for retention. Native vegetation (areas of sensitivity) should be included as a mapping overlay on any construction plans;
- Where possible, construction stockpiles, machinery, roads, and other infrastructure should be placed away from areas supporting native vegetation and wetlands;
- Ensure that best practice sedimentation and pollution control measures are undertaken at all times, in accordance with Environment Protection Authority guidelines (EPA 1991; EPA 1996; Victorian Stormwater Committee 1999) to prevent offsite impacts to waterways and wetlands; and,

- As indigenous flora provides valuable habitat for indigenous fauna, it is recommended that any landscape plantings that are undertaken as part of the proposed works are conducted using indigenous species sourced from a local provenance, rather than exotic deciduous trees and shrubs.

5.3 Offset Impacts and Strategy

According to DELWPs Native Vegetation Offset Register (DELWP 2022g), there are 23 offset sites within the Port Phillip and Westernport CMA and/or Cardinia Shire Council region that can be used to satisfy the General Habitat Unit and Large tree offset requirements.

An offset register search statement identifying the relevant offsite sites is provided in Appendix 4.

6 FURTHER REQUIREMENTS

Further requirements associated with development of the study area, as well as additional studies or reporting that may be required, are provided in Table 6.

Table 6. Further requirements associated with development of the study area.

Relevant Legislation	Implications	Further Action
Environment Protection and Biodiversity Conservation Act 1999	No nationally significant values were recorded within the study area or are considered likely to occur, and the proposed action is unlikely to have a significant impact on any matter of NES. As such, a referral to the Commonwealth Environment Minister is not required regarding matters listed under the EPBC Act.	No further action required.
Flora and Fauna Guarantee Act 1988	Two species listed as protected under the FFG Act were recorded within the study area, Prickly Moses and Shiny Cassinia. A total of two Prickly Moses and approximately 15 Shiny Cassinia are proposed to be removed. The study area occurs within private property, therefore a permit under the FFG Act will not be required for the removal of these species.	No further action required.
Mining Resources (Sustainable Development) Act 1990	A Work Plan variation will need to be updated in order to comply with the requirements of the MRSD Act. The offset requirement for native vegetation removal is 0.015 General Habitat Units and 1 Large Tree.	Prepare and submit a variation to the Work Plan.
Planning and Environment Act 1987	The clearing of native vegetation for mining and extractive industries is exempt from the requirement for a planning permit subject under the 'Stone Extraction' exemption detailed in Clause 52.17-7, and Clause 42.03 (SLO) of the Cardinia Shire Council planning scheme subject to an assessment as part of the work plan approval process (MRSD Act).	No further action required (for native vegetation removal).
Catchment and Land Protection Act 1994	Two weed species listed under the CaLP Act were recorded within the study area (Blackberry and Spear Thistle). To meet requirements under the CaLP Act, listed noxious weeds should be appropriately controlled throughout the study area.	Listed noxious weeds and pests should be appropriately controlled throughout the study area
Wildlife Act 1975	Any persons engaged to conduct salvage and translocation or general handling of terrestrial fauna species must hold a current Management Authorisation.	Ensure wildlife specialists hold a current Management Authorisation.

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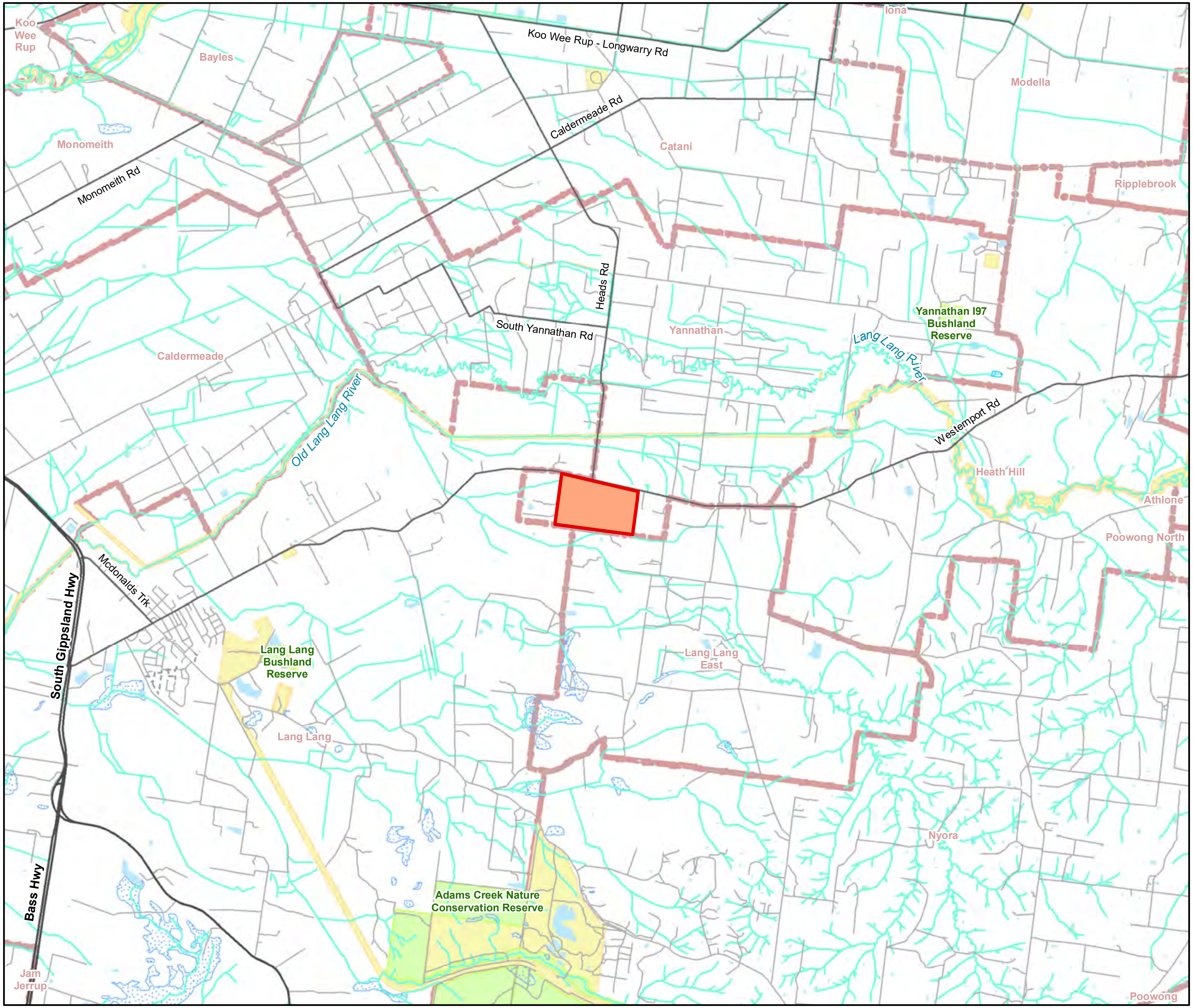


Legend

- Study Area
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Minor Watercourse
- Permanent Waterbody
- Land Subject to Inundation
- Wetland/Swamp
- Parks and Reserves
- Crown Land
- Localities

Figure 1

Location of the study area

Biodiversity Assessment at Yannathan Quarry

N

0 1 2

Kilometres

Map Scale: 1:75,000 @ A4

Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

14023_Fig01_StudyArea_G20 24/08/2020 melsley

Legend

- Extension area
- Total disturbed area
- Property boundary
- Realigned watercourse (indicative)
- Scattered Large Tree
- Large Tree in a patch
- Impacted tree

Noxious weed

- Blackberry
- Spear Thistle

Vegetation

- Swampy Riparian Woodland (EVC 83)
- Planted vegetation
- Naturally established regrowth
- Impacted vegetation

Figure 2

Ecological features

Biodiversity Assessment at Yannathan Quarry

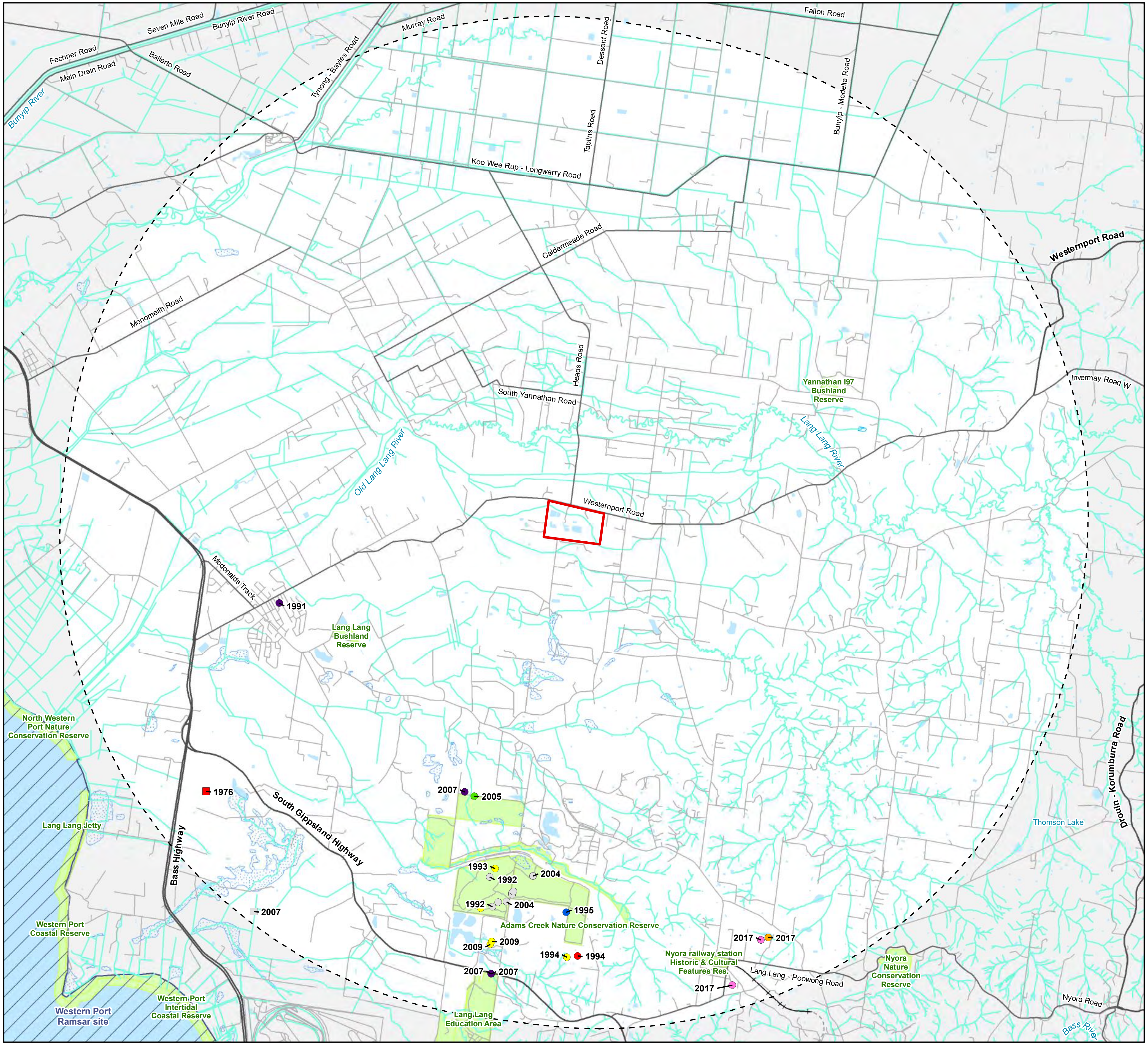
0 75 150
Metres

Map Scale: 1:5,700 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

14023_Fig02_EcoFeat_G20 14/09/2022 dvaladares

Aerial source: Nearmap 2020



Legend

Study Area

Significant flora

- Clasping Hypocreopsis
- Cobra Greenhood
- Giant Honey-myrtle
- Green-striped Greenhood
- Large-leaf Cinnamon-wattle
- Mauve-tuft Sun-orchid
- Spotted Gum
- Spurred Helmet-orchid
- Veined Spear-grass
- Velvet Apple-berry

Figure 3

Previously documented significant flora within 10km of the study area

Biodiversity Assessment at Yannathan Quarry

0 2 4

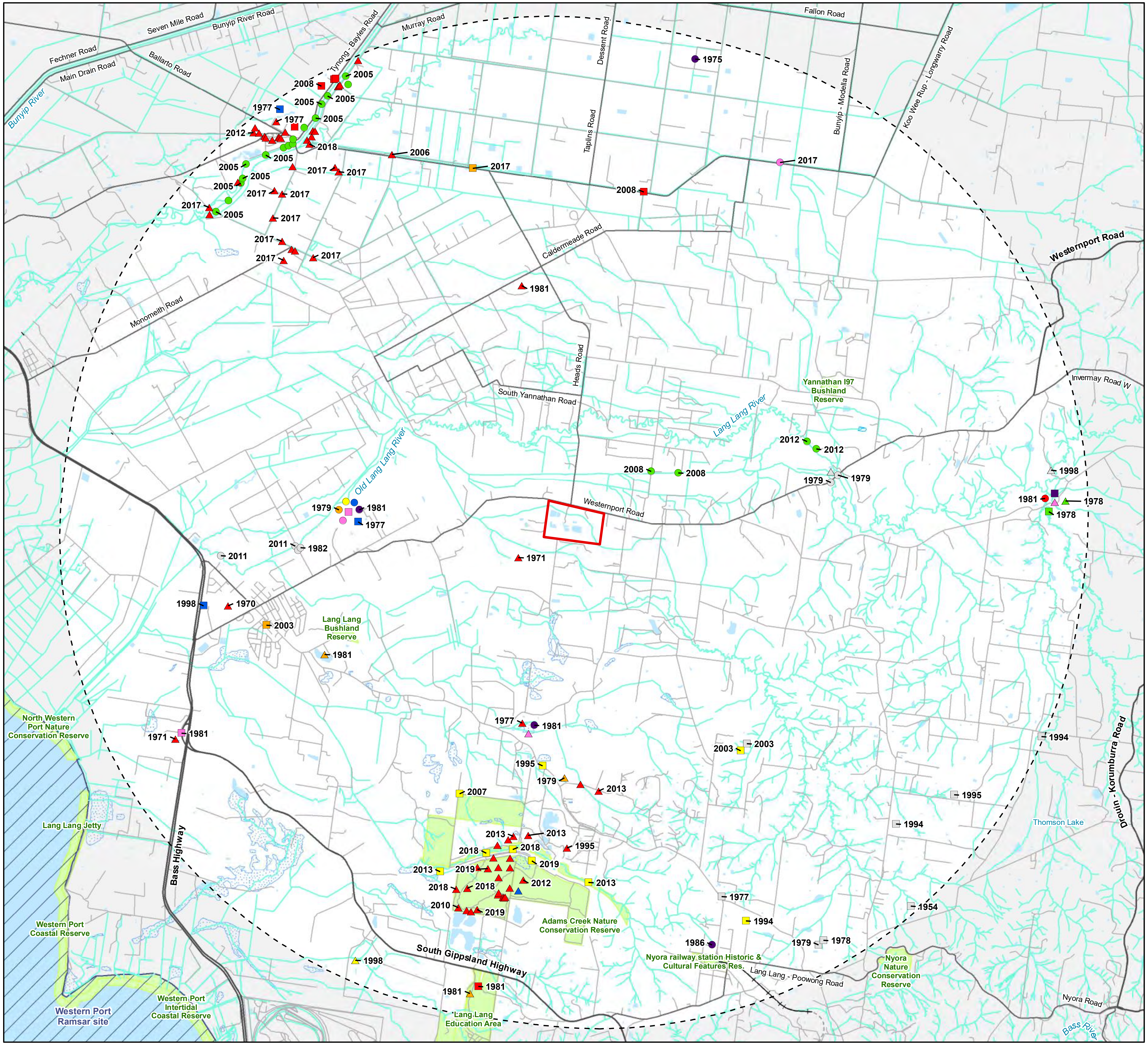
Kilometres

Map Scale: 1:75,000 @ A3

Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

14023_Fig03_SigFlora_G20 18/08/2022 melsley



Legend

Study Area

Significant fauna

- Australian Grayling
- Blue-billed Duck
- Caspian Tern
- Curlew Sandpiper
- Dwarf Galaxias
- Eastern Curlew
- Eastern Great Egret
- Gang-gang Cockatoo
- Giant Gippsland Earthworm
- Growling Grass Frog
- Hardhead
- Lace Monitor
- Little Eagle
- Little Egret
- Musk Duck
- Pilotbird
- Platypus
- Southern Brown Bandicoot
- Southern Toadlet
- Swamp Antechinus
- White-bellied Sea-Eagle
- White-footed Dunnart
- White-throated Needletail

Figure 4

Previously documented significant fauna within 10km of the study area

Biodiversity Assessment at Yannathan Quarry

0 2 4

Kilometres

Map Scale: 1:75,000 @ A3
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

Victorian Biodiversity Atlas (VBA) // Sourced from: 'VBA_FLORA25', 'VBA_FLORA100', 'VBA_FAUNA25' and 'VBA_FAUNA100', Updated May 2022 © The State of Victoria, Department of Environment, Land, Water and Planning. Records prior to 1949 not shown.

14023_Fig04_SigFauna_G20 18/08/2022 melsley

APPENDIX 1 FLORA

Appendix 1.1 Flora Results

Legend:

I Protected under the FFG Act (DELWP 2019);

***** Listed as a noxious weed under the CaLP Act;

+ Planted indigenous species that also occur in native vegetation in the study area;

****** Planted indigenous species in the study area;

w Weed of National Significance.

Table A1.1. Flora within the study area.

Scientific Name	Common Name	Notes
INDIGENOUS SPECIES		
Acacia melanoxylon	Blackwood	-
Acacia spp.	Wattle	-
Acacia verticillata	Prickly Moses	I
Allocasuarina littoralis	Black Sheoak	**
Cassinia longifolia	Shiny Cassinia	I
Eleocharis sphacelata	Tall Spike-sedge	-
Eucalyptus ovata	Swamp Gum	+
Eucalyptus radiata s.l.	Narrow-leaf Peppermint	**
Juncus pallidus	Pale Rush	-
Juncus spp.	Rush	-
Leptospermum continentale	Prickly Tea-tree	**
Melaleuca ericifolia	Swamp Paperbark	**
Phragmites australis	Common Reed	-
NON-INDIGENOUS OR INTRODUCED SPECIES		
Agrostis capillaris	Brown-top Bent	-
Anthoxanthum odoratum	Sweet Vernal-grass	-
Brassica spp.	Turnip	-
Bromus catharticus	Prairie Grass	-
Cirsium vulgare	Spear Thistle	*
Daucus carota	Carrot	-
Holcus lanatus	Yorkshire Fog	-
Hypochaeris radicata	Flatweed	-
Lolium perenne	Perennial Rye-grass	-

Scientific Name	Common Name	Notes
Lotus angustissimus	Slender Bird's-foot Trefoil	-
Malva parviflora	Small-flower Mallow	-
Paspalum dilatatum	Paspalum	-
Plantago lanceolata	Ribwort	-
Romulea rosea	Onion Grass	-
Rubus fruticosus spp. agg.	Blackberry	*w
Sonchus asper s.l.	Rough Sow-thistle	-
Trifolium spp.	Clover	-

Appendix 1.2 Habitat Hectare Assessment

Table A1.2. Habitat Hectare Assessment Table.

Vegetation Zone		SRF1	SRW7-SRF8 (regrowth)	SRF2-6; SRW9-13 (regrowth)
Bioregion		Gippsland Plain	Gippsland Plain	Gippsland Plain
EVC / Tree		Swampy Riparian Woodland	Swampy Riparian Woodland	Swampy Riparian Woodland
EVC Number		83	83	83
EVC Conservation Status		Endangered	Endangered	Endangered
Patch Condition	Large Old Trees /10	9	0	0
	Canopy Cover /5	4	0	0
	Under storey /25	10	5	5
	Lack of Weeds /15	2	2	2
	Recruitment /10	3	0	3
	Organic Matter /5	3	3	4
	Logs /5	2	0	0
	Treeless EVC Multiplier	1.00	1.00	1.00
	Subtotal =	33.00	10.00	14.00
Landscape Value /25		3	3	3
Habitat Points /100		36	13	17
Habitat Score		**0.36**	**0.13**	**0.17**

Appendix 1.3 Scattered Trees and Large Trees in Patches

Table A1.3. Scattered Trees and Large Trees in Patches.

Tree # (Figure 2)	Species Name	Common Name	DBH (cm)	Size Class	Scattered / Patch	Habitat features	Status
1	Swamp Gum	*Eucalyptus ovata*	96	Large	Scattered	-	Removed (direct impact)
27	stag	-	77	Large	Patch	Hollow	Retained
28	Swamp Gum	*Eucalyptus ovata*	74	Large	Patch	-	Retained
29	Swamp Gum	*Eucalyptus ovata*	72	Large	Patch	-	Retained
30	Swamp Gum	*Eucalyptus ovata*	70	Large	Patch	-	Retained
31	Swamp Gum	*Eucalyptus ovata*	72	Large	Patch	-	Retained

Appendix 1.4 Significant Flora Species

Significant flora within 10 kilometres of the study area is provided in the Table A1.4.3 at the end of this section, with Tables A1.4.1 and A1.4.2 below providing the background context for the values in Table 1.4.3.

Table A1.4.1 Conservation status of each species for each Act. The values in this table correspond to Columns 5 and 6 in Table A1.4.3.

EPBC (*Environment Protection and Biodiversity Conservation Act 1999*):		FFG (*Flora and Fauna Guarantee Act 1988*):	
EX	Extinct	ex	Extinct
CR	Critically endangered	cr	Critically endangered
EN	Endangered	en	Endangered
VU	Vulnerable	vu	Vulnerable
#	Listed on the Protected Matters Search Tool		

Table A1.4.2 Likelihood of occurrence rankings: Habitat characteristics assessment of significant flora species previously recorded within 10 kilometres of the study area, or that may potentially occur within the study area to determine their likelihood of occurrence. The values in this table correspond to Column 7 in Table A1.4.3.

1	Known Occurrence	• Recorded within the study area recently (i.e. within ten years).
2	High Likelihood	• Previous records of the species in the local vicinity; and/or, • The study area contains areas of high-quality habitat.
3	Moderate Likelihood	• Limited previous records of the species in the local vicinity; and/or • The study area contains poor or limited habitat.
4	Low Likelihood	• Poor or limited habitat for the species, however other evidence (such as lack of records or environmental factors) indicates there is a very low likelihood of presence.
5	Unlikely	• No suitable habitat and/or outside the species range.

Table A1.4.3 Significant flora recorded within 10 kilometres of the study area.

Scientific name	Common name	Total # of documented records	Last documented record	EPBC	FFG	Likely occurrence in study area
NATIONAL SIGNIFICANCE						
Amphibromus fluitans #	River Swamp Wallaby-grass	-	-	VU	-	4
Caladenia orientalis #	Eastern Spider Orchid	-	-	EN	en	5
Caladenia tessellata #	Thick-lipped Spider-orchid	-	-	VU	-	4
Dianella amoena #	Matted Flax-lily	-	-	EN	cr	4
Eucalyptus strzeleckii #	Strzelecki Gum	-	-	VU	cr	4
Glycine latrobeana #	Clover Glycine	-	-	VU	vu	4
Lepidium aschersonii #	Spiny Pepper-cress	-	-	VU	en	4
Prasophyllum spicatum #	Dense Leek-orchid	-	-	VU	cr	4
Pterostylis chlorogramma #	Green-striped Greenhood	5	2009	VU	en	4
Pterostylis cucullata #	Leafy Greenhood	-	-	VU	en	4
Senecio psilocarpus #	Swamp Fireweed	-	-	VU	-	4
Thelymitra epipactoides #	Metallic Sun-orchid	-	-	EN	en	4
Xerochrysum palustre #	Swamp Everlasting	-	-	VU	cr	4
STATE SIGNIFICANCE						
Acacia leprosa var. *uninervia*	Large-leaf Cinnamon-wattle	1	2005	-	en	4
Austrostipa rudis subsp. *australis*	Veined Spear-grass	1	2007	-	en	4
Billardiera scandens s.s.	Velvet Apple-berry	1	1976	-	en	4
Corybas aconitiflorus	Spurred Helmet-orchid	4	2007	-	en	4
Corymbia maculata	Spotted Gum	2	2017	-	vu	4

Scientific name	Common name	Total # of documented records	Last documented record	EPBC	FFG	Likely occurrence in study area
Hypocreopsis amplectens	Clasping Hypocreopsis	9	2004	-	cr	4
Melaleuca armillaris subsp. *armillaris*	Giant Honey-myrtle	1	2017	-	en	4
Pterostylis grandiflora	Cobra Greenhood	1	1994	-	en	4
Thelymitra malvina	Mauve-tuft Sun-orchid	1	1995	-	en	4

Data source: Victorian Biodiversity Atlas (DELWP 2022d); Protected Matters Search Tool (DCCEEW 2022).

APPENDIX 2 FAUNA

Appendix 2.1 Significant Fauna Species

Significant fauna within 10 kilometres of the study area is provided in the Table A2.1.3 at the end of this section, with Tables A2.1.1 and A2.1.2 below providing the background context for the values in Table 2.1.3.

Table A2.1.1 Conservation status of each species for each Act/Plan. The values in this table correspond to Columns 5 to 7 in Table A2.1.3.

EPBC (*Environment Protection and Biodiversity Conservation Act 1999*):		FFG (*Flora and Fauna Guarantee Act 1988*):	
EX	Extinct	EX	Extinct
CR	Critically endangered	CR	Critically endangered
EN	Endangered	EN	Endangered
VU	Vulnerable	VU	Vulnerable
CD	Conservation dependent	CD	Conservation dependent
#	Listed on the Protected Matters Search Tool		

Table A2.1.2 Likelihood of occurrence rankings: Habitat characteristics assessment of significant fauna species previously recorded within 10 kilometres of the study area, or that may potentially occur within the study area to determine their likelihood of occurrence. The values in this table correspond to Column 7 in Table A2.1.3.

1	High Likelihood	• Known resident in the study area based on site observations, database records, or expert advice; and/or, • Recent records (i.e. within five years) of the species in the local area (DELWP 2018); and/or, • The study area contains the species' preferred habitat.
2	Moderate Likelihood	• The species is likely to visit the study area regularly (i.e. at least seasonally); and/or, • Previous records of the species in the local area (DELWP 2021); and/or, • The study area contains some characteristics of the species' preferred habitat.
3	Low Likelihood	• The species is likely to visit the study area occasionally or opportunistically whilst en route to more suitable sites; and/or, • There are only limited or historical records of the species in the local area (i.e. more than 20 years old); and/or, • The study area contains few or no characteristics of the species' preferred habitat.

4	Unlikely	• No previous records of the species in the local area; and/or, • The species may fly over the study area when moving between areas of more suitable habitat; and/or, • Out of the species' range; and/or, • No suitable habitat present.

Table A2.1.3 Significant fauna recorded within 10 kilometres of the study area.

Common name	Scientific name	Total # of Records (VBA)	Last Documented Record (VBA)	EPBC	FFG	Likely occurrence in study area
NATIONAL SIGNIFICANCE						
Australasian Bittern #	*Botaurus poiciloptilus*	-	-	EN	cr	4
Australian Fairy Tern #	*Sternula nereis nereis*	-	-	VU	-	4
Australian Grayling	*Prototroctes maraena*	7	2011	VU	en	4
Australian Painted Snipe #	*Rostratula australis*	-	-	EN	cr	4
Broad-toothed Rat #	*Mastacomys fuscus mordicus*	-	-	VU	vu	4
Curlew Sandpiper	*Calidris ferruginea*	1	1979	CR	cr	4
Dwarf Galaxias	*Galaxiella pusilla*	25	2012	VU	en	4
Eastern Curlew	*Numenius madagascariensis*	2	1979	CR	cr	4
Gang-gang Cockatoo	*Callocephalon fimbriatum*	8	1986	EN	-	3
Giant Gippsland Earthworm	*Megascolides australis*	9	2003	VU	en	3
Golden Sun Moth #	*Synemon plana*	-	-	VU	vu	4
Greater Glider #	*Petauroides volans*	-	-	EN	vu	4
Greater Sand Plover #	*Charadrius leschenaultii*	-	-	VU	vu	4
Grey Falcon #	*Falco hypoleucos*	-	-	VU	vu	4

Common name	Scientific name	Total # of Records (VBA)	Last Documented Record (VBA)	EPBC	FFG	Likely occurrence in study area
Grey-headed Flying-fox #	*Pteropus poliocephalus*	-	-	VU	vu	4
Growling Grass Frog	*Litoria raniformis*	9	2008	VU	vu	4
Long-nosed Potoroo #	*Potorous tridactylus trisulcatus*	-	-	VU	vu	4
Nunivak Bar-tailed Godwit #	*Limosa lapponica baueri*	-	-	VU	-	4
Orange-bellied Parrot #	*Neophema chrysogaster*	-	-	CR	vu	4
Painted Honeyeater #	*Grantiella picta*	-	-	VU	vu	4
Pilotbird	*Pycnoptilus floccosus*	2	1977	VU	en	4
Red Knot #	*Calidris canutus*	-	-	EN	en	4
Regent Honeyeater #	*Anthochaera phrygia*	-	-	CR	en	4
Smoky Mouse #	*Pseudomys fumeus*	-	-	EN	en	4
Southern Brown Bandicoot	*Isoodon obesulus obesulus*	155	2019	EN	vu	3
Spot-tailed Quoll #	*Dasyurus maculatus maculatus*	-	-	EN	vu	4
Swamp Antechinus	*Antechinus minimus maritimus*	1	1998	VU	vu	4
White-throated Needletail	*Hirundapus caudacutus*	3	1981	VU	vu	4
Yarra Pygmy Perch #	*Nannoperca obscura*	-	-	VU	vu	4
Yellow-bellied Glider #	*Petaurus australis australis*	-	-	VU	-	4
STATE SIGNIFICANCE						
Blue-billed Duck	*Oxyura australis*	1	1981	-	vu	4
Caspian Tern	*Hydroprogne caspia*	1	1979	-	vu	4
Eastern Great Egret	*Ardea alba modesta*	2	2018	-	vu	4
Hardhead	*Aythya australis*	2	2017	-	vu	3

Common name	Scientific name	Total # of Records (VBA)	Last Documented Record (VBA)	EPBC	FFG	Likely occurrence in study area
Lace Monitor	*Varanus varius*	10	2019	-	en	3
Little Eagle	*Hieraaetus morphnoides*	3	1978	-	vu	3
Little Egret	*Egretta garzetta*	3	1998	-	en	4
Musk Duck	*Biziura lobata*	2	1981	-	vu	3
Platypus	*Ornithorhynchus anatinus*	4	1998	-	vu	4
Southern Toadlet	*Pseudophryne semimarmorata*	3	1981	-	en	3
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	1	1978	-	en	4
White-footed Dunnart	*Sminthopsis leucopus*	1	2012	-	vu	3

Data source: Victorian Biodiversity Atlas (DELWP 2022d); Protected Matters Search Tool (DCCEEW 2022).

APPENDIX 3 NATIVE VEGETATION REMOVAL (NVR) REPORT

Native vegetation removal report

A report to support an application to remove, destroy or lop native vegetation in the **Intermediate** Assessment Pathway using the modelled condition score

This report provides information to support an application to remove native vegetation in accordance with the *Guidelines for the removal, destruction or lopping of native vegetation*. The report is not an assessment by DELWP or local council of the proposed native vegetation removal. Biodiversity information and offset requirements have been calculated using modelled condition scores contained in the *Native vegetation condition map*.

Date and time: **13 January 2021 13:10 PM**

Lat./Long.: -38.247882976963,145.632626126845

Address: 870 WESTERNPORT ROAD YANNATHAN 3981

Native vegetation report ID: 311-20210113-012

Assessment pathway

The assessment pathway and reason for the assessment pathway

Assessment pathway	**Intermediate Assessment Pathway**
Extent of past plus proposed native vegetation removal	0.070 hectares
No. large trees	1 large tree(s)
Location category	Location 2 The native vegetation is in an area mapped as an Endangered Ecological Vegetation Class. Removal of less than 0.5 hectares of native vegetation will not have a significant impact on any habitat for a rare or threatened species.

Offset requirement

The offset requirement that will apply if the native vegetation is approved to be removed

Offset type	General offset
Offset amount	0.015 general habitat units
Offset attributes	
Vicinity	Port Phillip And Westernport Catchment Management Authority (CMA) or Cardinia Shire Council
Minimum strategic biodiversity value score	0.352
Large trees	1 large tree(s)

Biodiversity information about the native vegetation

Description of any past native vegetation removal

Any native vegetation that was approved to be removed, or was removed without the required approvals, on the same property or on contiguous land in the same ownership, in the five year period before the application to remove native vegetation is lodged is detailed below.

Permit/PIN number	Extent of native vegetation (hectares)
None entered	0 hectares

Description of the native vegetation proposed to be removed

Extent of all mapped native vegetation	0.070 hectares
Condition score of all mapped native vegetation	0.200
Strategic biodiversity value score of all mapped native vegetation	0.440
Extent of patches native vegetation	0.000 hectares
Extent of scattered trees	0.070 hectares
No. large trees within patches	0 large tree(s)
No. large scattered trees	1 large tree(s)
No. small scattered trees	0 small tree(s)

Additional information about trees to be removed, shown in Figure 1

Tree ID	Tree circumference (cm)	Benchmark circumference (cm)	Scattered / Patch	Tree size
A	301.6	220	Scattered	Large

Other information

Applications to remove, destroy or lop native vegetation must include all the below information. If an appropriate response has not been provided the application is not complete.

Photographs of the native vegetation to be removed

Recent, dated photographs of the native vegetation to be removed must be provided with the application. All photographs must be clear, show whether the vegetation is a patch of native vegetation or scattered trees, and identify any large trees. If the area of native vegetation to be removed is large, provide photos that are indicative of the native vegetation.

Ensure photographs are attached to the application. If appropriate photographs have not been provided the application is not complete.

Topographical and land information

Description of the topographic and land information relating to the native vegetation to be removed, including any ridges, crests and hilltops, wetlands and waterways, slopes of more than 20 percent, drainage lines, low lying areas, saline discharge areas, and areas of existing erosion, as appropriate. This may be represented in a map or plan. **This is an application requirement and your application will be incomplete without it.**

The study area is generally flat, with no ridges, crests within or immediately adjacent to the site. A minor drainage line is present within the study area, running east to west through the middle of the site.

Avoid and minimise statement

This statement describes what has been done to avoid the removal of, and minimise impacts on the biodiversity and other values of native vegetation. **This is an application requirement and your application will be incomplete without it.**

See Section 5 of the Biodiversity report

Defendable space statement

Where the removal of native vegetation is to create defendable space, a written statement explaining why the removal of native vegetation is necessary. This statement must have regard to other available bushfire risk mitigation measures. This statement is not required if your application also includes an application under the Bushfire Management Overlay.

Not applicable

Offset statement

An offset statement that demonstrates that an offset is available and describes how the required offset will be secured. **This is an application requirement and your application will be incomplete without it.**

Offsets will be sourced through the Native Vegetation Credit Register, with excess of 10 sites available (Appendix 4 of the Biodiversity Report).

Next steps

Applications to remove, destroy or lop native vegetation must address all the application requirements specified in *Guidelines for the removal, destruction or lopping of native vegetation.* If you wish to remove the mapped native vegetation you are required to apply for a permit from your local council. This *Native vegetation removal report* must be submitted with your application and meets most of the application requirements. The following needs to be added as applicable.

Property Vegetation Plan

Landowners can manage native vegetation on their property in the longer term by developing a Property Vegetation Plan (PVP) and entering in to an agreement with DELWP.

If an approved PVP applies to the land, ensure the PVP is attached to the application.

Applications under Clause 52.16

An application to remove, destroy or lop native vegetation is under Clause 52.16 if a Native Vegetation Precinct Plan (NVPP) applies to the land, and the proposed native vegetation removal is not in accordance with the relevant NVPP. If this is the case, a statement that explains how the proposal responds to the NVPP considerations must be provided.

If the application is under Clause 52.16, ensure a statement that explains how the proposal responds to the NVPP considerations is attached to the application.

Authorised by the Victorian Government, 8 Nicholson Street, East Melbourne.

For more information contact the DELWP Customer Service Centre 136 186

www.delwp.vic.gov.au

Figure 1 – Map of native vegetation to be removed, destroyed or lopped

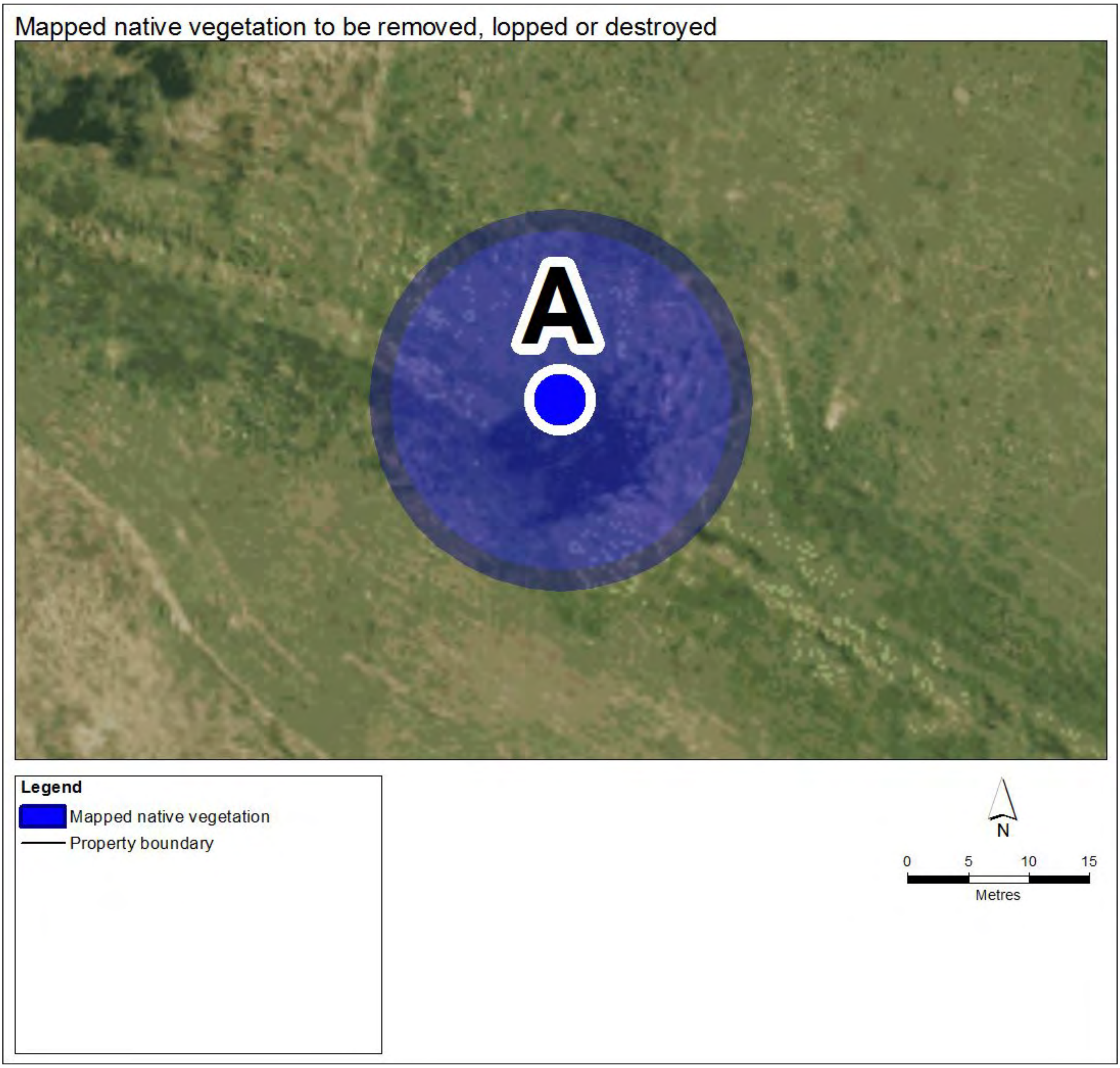
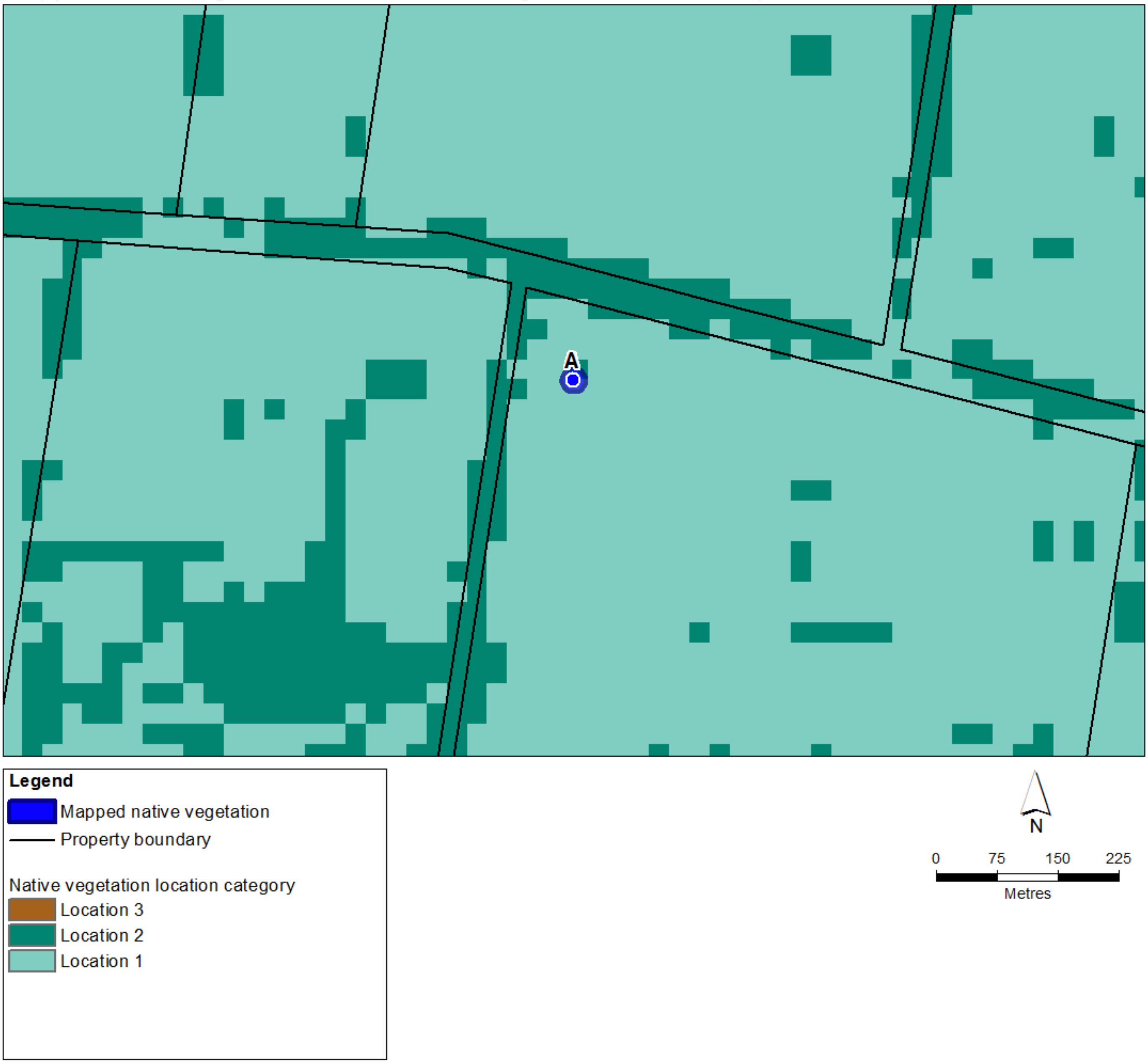


Figure 2 – Map of property in context

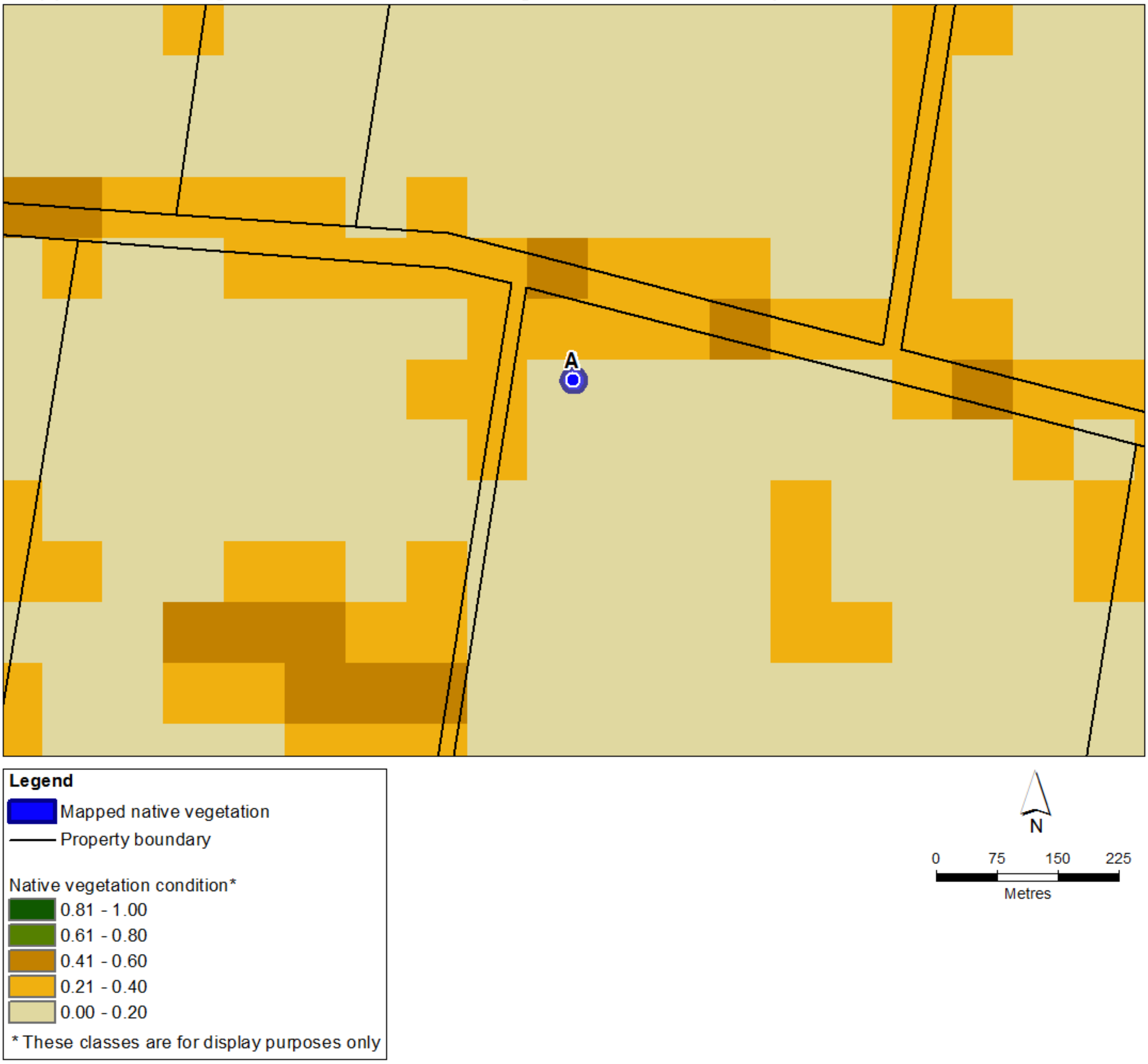
Property view of mapped native vegetation

Figure 3 – Biodiversity information maps

Mapped native vegetation and the *Native vegetation location map*



Mapped native vegetation and the *Native vegetation condition map*



Mapped native vegetation and the *Strategic biodiversity value map*

Appendix 1 - Details of offset requirements

Native vegetation to be removed

Extent of all mapped native vegetation (for calculating habitat hectares)	0.070	The area of land covered by a patch of native vegetation and/or a scattered tree, measured in hectares. Where the mapped native vegetation includes scattered trees, each tree is assigned a standard extent and converted to hectares. A small scattered tree is assigned a standard extent defined by a circle with a 10 metre radius and a large scattered tree a circle with a 15 metre radius. The extent of all mapped native vegetation is an input to calculating the habitat hectares.
Condition score*	0.200	The condition score of native vegetation is a site-based measure that describes how close native vegetation is to its mature natural state. The condition score is the weighted average condition score of the mapped native vegetation calculated using the *Native vegetation condition map.*
Habitat hectares	0.014	Habitat hectares is a site-based measure that combines extent and condition of native vegetation. It is calculated by multiplying the extent of native vegetation by the condition score: ***Habitat hectares = extent x condition score***
Strategic biodiversity value score	0.440	The strategic biodiversity value score represents the complementary contribution to Victoria's biodiversity of a location, relative to other locations across the state. This score is the weighted average strategic biodiversity value score of the mapped native vegetation calculated using the *Strategic biodiversity value map*.
General landscape factor	0.720	The general landscape factor is an adjusted strategic biodiversity value score. It has been adjusted to reduce the influence of landscape scale information on the general habitat score.
General habitat score	0.010	The general habitat score combines site-based and landscape scale information to obtain an overall measure of the biodiversity value of the native vegetation. The general habitat score is calculated as follows: ***General habitat score = habitat hectares x general landscape factor***

* **Offset requirements for partial removal:** If your proposal is to remove parts of the native vegetation in a patch (for example only understorey plants) the condition score must be adjusted. This will require manual editing of the condition score and an update to the calculations that the native vegetation removal tool has provided: habitat hectares, general habitat score and offset amount.

Offset requirements

Offset type	General offset	A general offset is required when the removal of native vegetation does not have a significant impact on any habitat for rare or threatened species. All proposals in the Basic and Intermediate assessment pathways will only require a general offset.
Offset multiplier	1.5	This multiplier is used to address the risk that the predicted outcomes for gain will not be achieved, and therefore will not adequately compensate the biodiversity loss from the removal of native vegetation.
Offset amount (general habitat units)	0.015	The general habitat units are the amount of offset that must be secured if the application is approved. This offset requirement will be a condition to any permit or approval for the removal of native vegetation. ***General habitat units required = general habitat score x 1.5***
Minimum strategic biodiversity value score	0.352	The offset site must have a strategic biodiversity value score of at least 80 per cent of the strategic biodiversity value score of the native vegetation to be removed. This is to ensure offsets are located in areas with a strategic biodiversity value that is comparable to the native vegetation to be removed.
Vicinity	Port Phillip And Westernport CMA or Cardinia Shire Council	The offset site must be located within the same Catchment Management Authority boundary or municipal district as the native vegetation to be removed.
Large trees	1 large tree (s)	The offset site must protect at least one large tree for every large tree removed. A large tree is a native canopy tree with a Diameter at Breast Height greater than or equal to the large tree benchmark for the local Ecological Vegetation Class. A large tree can be either a large scattered tree or a large patch tree.

APPENDIX 4 AVAILABLE NATIVE VEGETATION CREDITS

Report of available native vegetation credits

This report lists native vegetation credits available to purchase through the Native Vegetation Credit Register.

This report is **not evidence** that an offset has been secured. An offset is only secured when the units have been purchased and allocated to a permit or other approval and an allocated credit extract is provided by the Native Vegetation Credit Register.

Date and time: 06/09/2022 03:15 **Report ID: 15759**

What was searched for?

General offset

General habitat units	Strategic biodiversity value	Large trees	Vicinity (Catchment Management Authority or Municipal district)	
0.015	0.352	1	CMA	Port Phillip and Westernport
			or LGA	Cardinia Shire

Details of available native vegetation credits on 06 September 2022 03:15

These sites meet your requirements for general offsets.

Credit Site ID	GHU	LT	CMA	LGA	Land owner	Trader	Fixed price	Broker(s)
BBA-0670	17.745	147	Port Phillip and Westernport	Cardinia Shire	No	Yes	No	Abezco, VegLink
BBA-0677	16.525	1492	Port Phillip and Westernport	Whittlesea City	No	Yes	No	Abezco, VegLink
BBA-0678	46.362	2627	Port Phillip and Westernport	Nillumbik Shire	No	Yes	No	VegLink
BBA-0678_2	0.388	59	Port Phillip and Westernport	Nillumbik Shire	No	Yes	No	VegLink
BBA-2774	0.020	9	Port Phillip and Westernport	Greater Geelong City	Yes	Yes	No	VegLink
BBA-2789	1.317	14	Port Phillip and Westernport	Baw Baw Shire	Yes	Yes	No	Contact NVOR
BBA-2790	2.911	116	Port Phillip and Westernport	Baw Baw Shire	Yes	Yes	No	Contact NVOR
BBA-2870	2.544	431	Port Phillip and Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
BBA-2871	16.335	1668	Port Phillip and Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
TFN-C1650	0.098	20	Port Phillip and Westernport	Yarra Ranges Shire	Yes	Yes	Yes	Yarra Ranges SC
TFN-C1663	0.109	27	Port Phillip and Westernport	Yarra Ranges Shire	Yes	Yes	Yes	Yarra Ranges SC
TFN-C1664	2.570	65	Port Phillip and Westernport	Yarra Ranges Shire	Yes	Yes	No	Yarra Ranges SC
TFN-C1962	0.098	9	Goulburn Broken, Port Phillip and Westernport	Macedon Ranges Shire	No	Yes	No	Contact NVOR

VC_CFL-0838_01	0.209	697	Port Phillip And Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3084_01	0.498	386	Port Phillip And Westernport	Cardinia Shire	Yes	Yes	No	VegLink
VC_CFL-3084_02	0.613	56	Port Phillip And Westernport	Cardinia Shire	Yes	Yes	No	VegLink
VC_CFL-3687_01	0.728	78	Port Phillip And Westernport	Baw Baw Shire	Yes	Yes	No	Baw Baw SC
VC_CFL-3708_01	0.199	511	Port Phillip And Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3709_01	0.139	395	Port Phillip And Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3729_01	0.016	6	Port Phillip And Westernport	Melton City	Yes	Yes	No	VegLink
VC_CFL-3740_01	1.756	96	Port Phillip And Westernport	Cardinia Shire, Yarra Ranges Shire	Yes	Yes	No	Bio Offsets
VC_CFL-3740_01	0.365	22	Port Phillip And Westernport	Yarra Ranges Shire	Yes	Yes	No	Bio Offsets
VC_CFL-3762_01	0.549	125	Port Phillip And Westernport	Moorabool Shire	Yes	Yes	No	VegLink

These sites meet your requirements using alternative arrangements for general offsets.

Credit Site ID	GHU	LT	CMA	LGA	Land owner	Trader	Fixed price	Broker(s)

There are no sites listed in the Native Vegetation Credit Register that meet your offset requirements when applying the alternative arrangements as listed in section 11.2 of the Guidelines for the removal, destruction or lopping of native vegetation.

These potential sites are not yet available, land owners may finalise them once a buyer is confirmed.

Credit Site ID	GHU	LT	CMA	LGA	Land owner	Trader	Fixed price	Broker(s)
VC_CFL-3710_01	7.606	322	Port Phillip And Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3744_01	3.717	384	Port Phillip And Westernport	Macedon Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3746_01	4.962	563	Port Phillip And Westernport	Macedon Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3764_01	12.037	55	Port Phillip And Westernport	Yarra Ranges Shire	Yes	Yes	No	VegLink
VC_CFL-3769_01	2.617	77	Port Phillip And Westernport	Nillumbik Shire	Yes	Yes	No	VegLink

LT - Large Trees *CMA - Catchment Management Authority* *LGA - Municipal District or Local Government Authority*

Next steps

If applying for approval to remove native vegetation
Attach this report to an application to remove native vegetation as evidence that your offset requirement is currently available.

If you have approval to remove native vegetation
Below are the contact details for all brokers. Contact the broker(s) listed for the credit site(s) that meet your offset requirements. These are shown in the above tables. If more than one broker or site is listed, you should get more than one quote before deciding which offset to secure.

Broker contact details

Broker Abbreviation	Broker Name	Phone	Email	Website
Abezco	Abzeco Pty. Ltd.	(03) 9431 5444	offsets@abzeco.com.au	www.abzeco.com.au
Baw Baw SC	Baw Baw Shire Council	(03) 5624 2411	bawbaw@bawbawshire.vic.gov.au	www.bawbawshire.vic.gov.au
Bio Offsets	Biodiversity Offsets Victoria	0452 161 013	info@offsetsvictoria.com.au	www.offsetsvictoria.com.au
Contact NVOR	Native Vegetation Offset Register	136 186	nativevegetation.offsetregister@delwp.vic.gov.au	www.environment.vic.gov.au/native-vegetation
Ecocentric	Ecocentric Environmental Consulting	0410 564 139	ecocentric@me.com	Not avaliable
Ethos	Ethos NRM Pty Ltd	(03) 5153 0037	offsets@ethosnrm.com.au	www.ethosnrm.com.au
Nillumbik SC	Nillumbik Shire Council	(03) 9433 3316	offsets@nillumbik.vic.gov.au	www.nillumbik.vic.gov.au
TFN	Trust for Nature	8631 5888	offsets@tfn.org.au	www.trustfornature.org.au
VegLink	Vegetation Link Pty Ltd	(03) 8578 4250 or 1300 834 546	offsets@vegetationlink.com.au	www.vegetationlink.com.au
Yarra Ranges SC	Yarra Ranges Shire Council	1300 368 333	biodiversityoffsets@yarraranges.vic.gov.au	www.yarraranges.vic.gov.au

For more information contact the DELWP Customer Service Centre 136 186 or the Native Vegetation Credit Register at nativevegetation.offsetregister@delwp.vic.gov.au

Appendix G Cultural Heritage

Bunurong Land Council
ABORIGINAL CORPORATION

ABN: 66 129 413 297   ICN:3630
PO Box 11219, Frankston VIC 3199
336-340 Nepean Hwy, Frankston VIC 3199
Ph: (03) 9770 1273
www.bunuronglc.org

30 January 2023

To whom it may concern,

Approval Notice for Cultural Heritage Management Plan 17359 – Proposed Expansion at Yannathan Quarry, Yannathan. Cover date: 30 December 2022.

We refer to your application to the Bunurong Land Council Aboriginal Corporation requesting approval of the above cultural heritage management plan (CHMP).

With reference to section 63(1)(a)(i) of the *Aboriginal Heritage Act 2006* (Act), the Bunurong Land Council Aboriginal Corporation as the Registered Aboriginal Party (RAP), have evaluated and approved this CHMP. The conditions set out in this CHMP are now compliance requirements.

Kind regards,

Steven Pepper
Cultural Heritage Manager
steven.pepper@bunuronglc.org.au

*This notice of approval must be inserted after the title page and bound with the body of the CHMP

STATEMENT OF ACKNOWLEDGEMENT

Our community culturally and spiritually acknowledge our ancestors who have provided our community today with the opportunity to continue to practice our culture and be a representative voice for our land, waters and community. We value and acknowledge the relationships we have with all practitioners on Bunurong country to facilitate and nurture the protection and preservation of our shared culture, Bunurong culture.

Department of Jobs, Precincts and Regions

DECLARATION OF CULTURAL HERITAGE MANAGEMENT PLAN REQUIREMENT

It is the responsibility of the applicant, as the proponent of the activity requiring approval, to determine if a Cultural Heritage Management Plan is required under the *Aboriginal Heritage Act 2006*.

For further information please contact Aboriginal Victoria on 1800 762 003 or at aboriginalaffairs@dpc.vic.gov.au

This form, including the printable process list from the self-assessment conducted in Step1 must be completed, signed and submitted with the work plan.

Step 1
Complete a self-assessment using the Aboriginal Heritage Planning Tool available from the Aboriginal Victoria website.

https://www.aboriginalvictoria.vic.gov.au/cultural-heritage-management-plans

Step 2
Please advise which is applicable to your proposed work plan and include the:

A Cultural Heritage Management Plan is **NOT** required: ☐

An **approved** Cultural Heritage Management Plan is attached: ☐

An approved Cultural Heritage Management Plan **will be provided with the work plan** for approval: ✓

Step 3
Sign* this form and submit it with the work plan.

I declare that the above information is true and correct and the tenement holder / applicant (*if not myself*) has been advised.

Name (print)………DAVID PALLOT…………………………………………………………………………

I am the: **Tenement Holder** x (Attorney) **Tenement Applicant** ☐ **Agent** ☐

DPallot

Signature ……………………………………………………………………………………..

Date ………5th October 2022………………………………

* *Please be advised that it is against the law to provide false or misleading information.*

VICTORIA State Government

Proposed Expansion at Yannathan Quarry, Yannathan

Cultural Heritage Management Plan

First Peoples-State Relations Management Plan Identifier: 17359

Sponsor: Hanson Construction Materials Pty Ltd

Heritage Advisors: Bianca Di Fazio, Simon Coxe and Renee McAlister

Authors: Simon Coxe, Renee McAlister, Lana Tranter-Edwards & Bianca Di Fazio

December 30, 2022

Heritage Insight Pty Ltd

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Bunurong Land Council
ABORIGINAL CORPORATION

ABN: 66 129 413 297 ICN:3630
PO Box 11219, Frankston VIC 3199
336-340 Nepean Hwy, Frankston VIC 3199
Ph: (03) 9770 1273
www.bunuronglc.org

30 January 2023

To whom it may concern,

Approval Notice for Cultural Heritage Management Plan 17359 – Proposed Expansion at Yannathan Quarry, Yannathan. Cover date: 30 December 2022.

We refer to your application to the Bunurong Land Council Aboriginal Corporation requesting approval of the above cultural heritage management plan (CHMP).

With reference to section 63(1)(a)(i) of the *Aboriginal Heritage Act 2006* (Act), the Bunurong Land Council Aboriginal Corporation as the Registered Aboriginal Party (RAP), have evaluated and approved this CHMP. The conditions set out in this CHMP are now compliance requirements.

Kind regards,

Steven Pepper
Cultural Heritage Manager
steven.pepper@bunuronglc.org.au

*This notice of approval must be inserted after the title page and bound with the body of the CHMP

STATEMENT OF ACKNOWLEDGEMENT
Our community culturally and spiritually acknowledge our ancestors who have provided our community today with the opportunity to continue to practice our culture and be a representative voice for our land, waters and community. We value and acknowledge the relationships we have with all practitioners on Bunurong country to facilitate and nurture the protection and preservation of our shared culture, Bunurong culture.

Title Page

TITLE:	Proposed expansion at Yannathan Quarry, Yannathan
ACTIVITY:	Expansion of extraction area
LOCATION:	870–910 Westernport Rd, Yannathan VIC 3984
LEVEL OF ASSESSMENT:	Desktop, standard, complex
SIZE OF ACTIVITY:	Medium
ABORIGINAL HERITAGE PRESENT:	Yes
FP-SR PLAN IDENTIFIER:	17359
DATE OF COMPLETION:	December 30, 2022
SPONSOR:	Hanson Construction Materials Pty Ltd
ABN/ACN:	90 009 679 734
HERITAGE ADVISOR:	Bianca Di Fazio, Simon Coxe and Renee McAlister
AUTHORs:	Simon Coxe, Renee McAlister, Lana Tranter-Edwards & Bianca Di Fazio

Acknowledgments

Heritage Insight Pty Ltd would like to acknowledge and thank the following people for their assistance and participation in this study:

Bunurong Land Council Aboriginal Corporation

Heritage manager:	Robert Ogden
Senior archaeologist/heritage advisor:	Bradley Ward
Cultural heritage officers:	Wayne Pepper, Iris Pepper, Minta Franks & Richard Cole

Heritage Insight Staff

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Background research:	Thomas Fallon
Data compilation:	Anthony Hamdorf
Report editing:	Bronwyn Hislop

Belmara Industries Pty Ltd

Machine operators: Darren Keetch

The Sponsor and/or Sponsor's Agent

Kathy MacInnes (Ricardo)
Gunther Benedek (Hanson Construction Materials Pty Ltd)

Disclaimer

The information contained in this Cultural Heritage Management Plan (CHMP) has been compiled from the standard heritage database sources and is accurate as far as Heritage Insight Pty Ltd is aware. However, within the timeframes available for technical heritage reporting, it is not possible to carry out comprehensive research of all published or unpublished manuscripts, journals, maps or oral history which may pertain to the study area. No responsibility can be taken for errors or omissions in primary and secondary source material cited in this report. Any opinions expressed in this report are those of Heritage Insight Pty Ltd and do not necessarily represent those of the Sponsor. Heritage Insight has endeavoured to actively consult with representatives of the Bunurong Land Council Aboriginal Corporation who are, to the best of our knowledge and advice, the legal and proper representatives of the local Aboriginal community. The consultants cannot, however, be held responsible for opinions or actions which may be expressed by dissenting persons or organisations. This CHMP has been prepared to comply with the approved form under clause r.68 of the *Aboriginal Heritage Regulations 2018*. However, Heritage Insight Pty Ltd cannot be responsible for any changes in policy on the part of the Victorian Government, its agencies, or Registered Aboriginal Parties in the period since lodging a Notice of Intent to Prepare a CHMP.

Copyright Notice

Executive Summary

Compliance requirements are set out in Part 1 of the Cultural Heritage Management Plan.

This Cultural Heritage Management Plan (CHMP) has been undertaken at the request of the Sponsor, Hanson Construction Materials Pty Ltd, for a proposed expansion of the extraction area at Yannathan Quarry. This is a mandatory CHMP because the proposed activity area is considered an area of cultural heritage sensitivity because the activity area contains previously registered Aboriginal Places (VAHR 8021-0369; VAHR 8021-0370; VAHR 8021-0373; and VAHR 8021-0374, as well as six Object Collections that represent reburials within the site extent of VAHR 8021-0374)(r.25) and is located within a sandy dune landform (r.40).

The activity area is located at 870-910 Westernport Road, Yannathan, 80km south east of Melbourne. The activity area is approximately 30.3ha. The proposed activity is the extraction of sand.

The desktop assessment identified 21 registered Aboriginal Places within the geographic region, comprising a total of 61 components. Site types within the geographic region, apart from object collections, include artefact scatters and earth features. The artefacts occur in varying densities from isolated stone artefacts to scatters of up to 22 pieces. The majority occur either within sandy rises or along waterways. Four registered Places and six object collections are located within the activity area. The desktop assessment concluded that there is potential for Aboriginal cultural heritage to be present in the activity area due to the presence of the inland dune formation (Qd1) and the presence of a previously registered site within the activity area.

The standard assessment noted that no known surface deposits of Aboriginal cultural material were located within the activity area. The southern section, central section and northern bunds of the activity area have been impacted by disturbance associated with quarrying activities permitted under a previous CHMP. The low-lying paddocks between the bunds and the quarry are waterlogged and are considered to contain low archaeological potential, given their proximity to known Aboriginal Places and former swamp margins. It is considered likely that any Aboriginal cultural material identified will comprise disturbed deposits of low densities of stone material.

The standard assessment concluded that a complex assessment was required, as per r.64 (*Aboriginal Heritage Regulations 2018*). While the nature, extent and significance of VAHR 8021-0374 is known, the BLCAC requested that additional complex assessment testing occur to more fully understand the archaeological potential of the low-lying paddocks within the activity area, given the limited nature of testing that had previously occurred on this landform.

During the complex assessment a total of 12 2x1m machine excavation trenches were excavated across the activity area in order to assess the likelihood of Aboriginal cultural material being present and to establish a profile of the soils within the activity area. The complex assessment was conducted across the alluvial plain landform identified during the standard assessment.

<u>Aboriginal cultural material was not located during this CHMP assessment, however cultural material was already present within the activity area.</u>

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Abbreviations

AAG – Activity Advisory Group
ACHRIS – Aboriginal Cultural Heritage Register and Information System
AHD – Australian Height Datum
AP – Auger Probe

ASL – Above Sea Level
BLCAC – Bunurong Land Council Aboriginal Corporation
CBD – Central Business District
CHMP – Cultural Heritage Management Plan
DBYD – Dial Before You Dig
dGPS or differential GPS – Differential Global Positioning System
DPC – Department of Premier and Cabinet
EVC – Ecological Vegetation Class
EXT – Extent Trench
FP-SR – First Peoples-State Relations (formerly Aboriginal Victoria, AV)
GDA94 – Geocentric Datum of Australia 1994
GMU – Geomorphic Unit
HA – Heritage Advisor
HV – Heritage Victoria
ICOMOS – International Council on Monuments and Sites
LDAD – Low Density Artefact Distribution
LGA – Local Government Area
LGM – Last Glacial Maximum
MGA – Map Grid of Australia
MMBW – Melbourne & Metropolitan Board of Works
MT – Machine Trench
NDA – Net Developable Area
NOI – Notice of Intent to Prepare a CHMP
OHS – Occupational Health and Safety
PAD – Potential Archaeological Deposit
PAS – Potential Archaeological Sensitivity
PSP – Precinct Structure Plan
RAP – Registered Aboriginal Party
RTP – Radial Shovel Test Pit
STP – Shovel Test Pit
T – Transect
TO – Traditional Owner
TP – Test Pit
VAHC – Victorian Aboriginal Heritage Council
VAHR – Victorian Aboriginal Heritage Register

Please note that all maps and plans in this CHMP are prepared using Victorian Government Standard GDA94 MGA coordinates (Zone 55).

A glossary of terms is provided in Appendix 4.

Part One: Cultural Heritage Management Conditions

These conditions become compliance requirements once the Cultural Heritage Management Plan is approved. Failure to comply with a condition is an offence under Section 67A of the *Aboriginal Heritage Act 2006*.

The Cultural Heritage Management Plan must be readily accessible to the Sponsor and their employees and contractors when carrying out the activity.

1.0 Cultural Heritage Management Conditions

1.1 General Cultural Heritage Management Conditions

Condition 1: Adherence to the Cultural Heritage Management Plan (CHMP) Before, During and After the Activity

1. A copy of the approved CHMP must always be available and accessible on-site for the duration of the activity.
2. The Sponsor, site supervisor and all relevant personnel must be aware of the compliance requirements of the CHMP.
3. The Sponsor or site supervisor is responsible for ensuring that all personnel on-site are aware of the management conditions and contingency plans, and of the on-site location of the hard copy of the approved CHMP.
4. The Sponsor, site supervisor and all relevant personnel are responsible for implementing the management conditions contained within the CHMP.
5. The Sponsor or site supervisor is responsible for ensuring that the activity adheres to the activity description as detailed in Section 5 of the CHMP. Any change to the activity area, the activity description or the approved management conditions may require either an amendment to the CHMP or the preparation of a new CHMP.

Condition 2: Cultural Heritage Induction to be Undertaken Before the Activity

1. A cultural heritage induction must be undertaken prior to the commencement of the activity within the activity area and must include the site supervisor for the activity.
2. The Sponsor or site contractor must submit a booking request to BLCAC at least two weeks before the cultural heritage induction is required.
3. The cultural heritage induction must be conducted by the BLCAC Heritage Unit, however any subsequent inductions may be given by the site supervisor for the activity.
4. The cultural heritage induction must include the Sponsor or their representative/project manager and where possible, the site supervisor and all relevant personnel directly involved in ground disturbing works within the activity area.
5. The cost of the cultural heritage induction must be met by the Sponsor or site contractor.
6. The Sponsor or site contractor must indicate during the induction both the commencement date of the activity and the likely completion date of the activity.

Condition 3: Protocol for Handling Sensitive Information Before, During and After the Activity

1. Apart from publicly available information there shall be no communication or public release of information concerning Aboriginal cultural heritage without the written permission of the BLCAC.
2. No photographs of on-site cultural heritage, or information concerning Aboriginal cultural heritage is to be circulated to the media or via public media without the written permission of the BLCAC.

Condition 4: Site Inspections

BLCAC representatives participating in site inspections must comply with all Occupational Health and Safety conditions applicable to the activity area.

1. A site inspection must be scheduled for the following occasions:

   a. Following ground stripping and preparation; and
   b. Following realignment of the watercourse at a time when soils are exposed.

2. Scheduled site inspections must be carried out by the BLCAC Heritage Unit.

3. The Sponsor is responsible for meeting the costs of the site inspections identified in the above point.

It is the Sponsor's responsibility to ensure that the RAP inspections are organised for the appropriate times as set out above.

If the RAP inspection/s reveals suspected non-compliance with the approved CHMP, then the procedure outlined in Section 2.7 will be initiated by the Sponsor. This procedure must be organised by the Sponsor.

The BLCAC requires a minimum of two weeks' notice for inspections.

Condition 5: Development of an Interpretive Strategy

Before, during or after the activity, the Sponsor must undertake formal consultation with the BLCAC to develop an appropriate interpretive strategy for the area determined to be the reburial location of all cultural material. The agreed interpretive strategy must be implemented for the activity area. The formal consultation must be organised and paid for by the Sponsor.

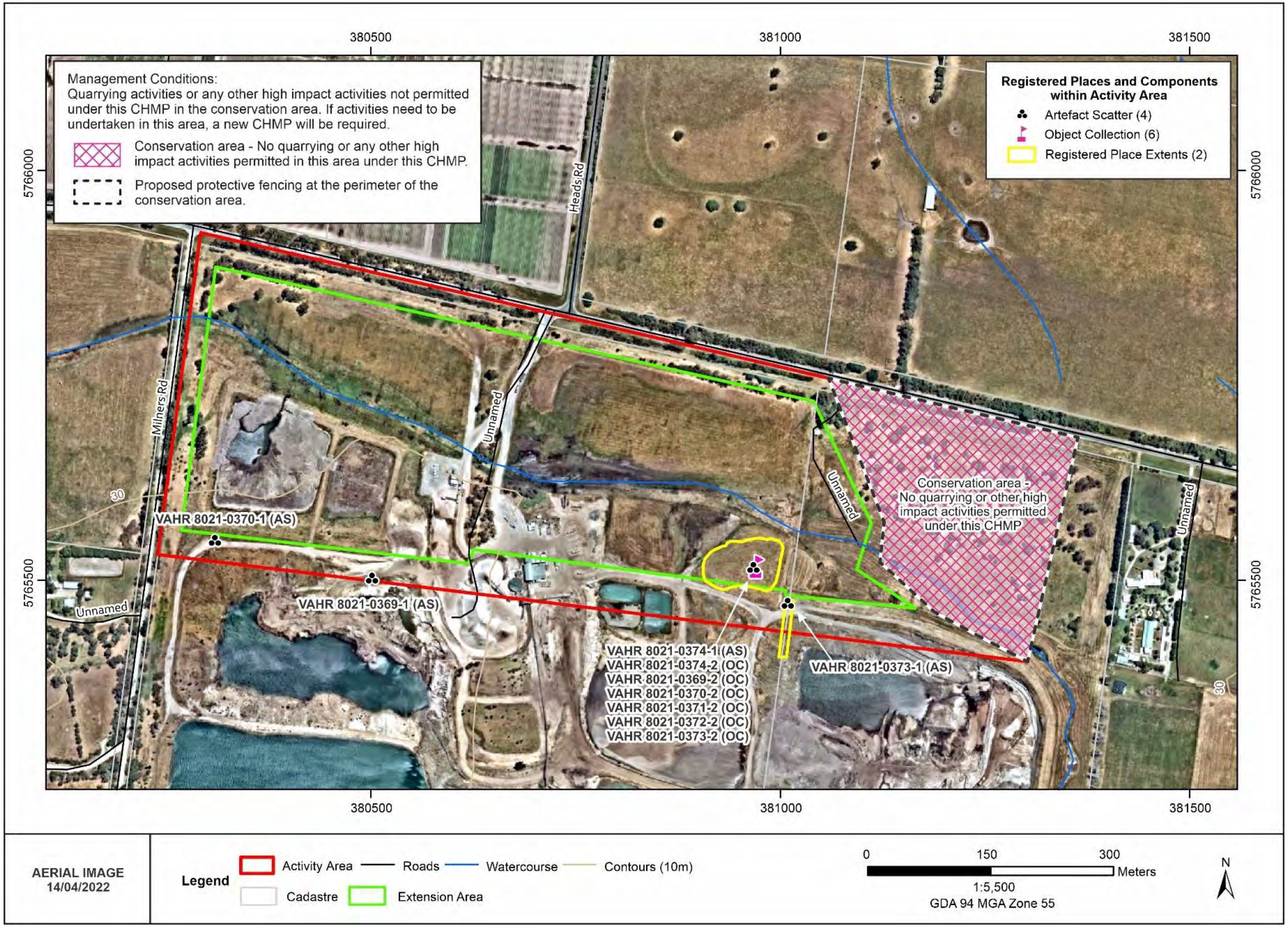
Condition 6: No High Impact Activities Permitted in Conservation Area

Because the conservation area in the north east corner of the activity was not subject to assessment during this CHMP, no quarrying activities are permitted in this part of the activity area, and nor are any other high impact activities listed in the *Aboriginal Heritage Regulations 2018* (see Conditions Map 1). If any future quarrying of this land is required it will require either an amendment to this CHMP (if the amendment is completed within five years of the approval date of this CHMP), or alternatively preparation of a new CHMP.

Activities that are permitted in this area relate only to the management of this land as a conservation area, and include weed control, grass slashing, seeding and planting.

Protective fencing and signage must be installed around the perimeter of the conservation area in order to protect this area from accidental harm during quarrying works. The specific type of fencing must be agreed between BLCAC and the Sponsor, and it must be clearly marked as a no go zone on both the fencing itself, and on all plans relating to the activity.

The protective fencing must remain in place for the duration of works within the activity area.



Conditions Map 1: No High Impact Activities in Conservation Area

Condition 7: Contingency Plans

There must also be a system for reporting any possible Aboriginal cultural heritage which may be discovered or uncovered during the conduct of the proposed activity. To this end, the contingency plans in Section 2 must be incorporated into the development documentation and risk assessment for the project.

1.2 Specific Cultural Heritage Management Conditions

Condition 8: Relocation of Object Collections VAHR 8021-0369-2; VAHR 8021-0370-2; VAHR 8021-0371-2; VAHR 8021-0372-2; VAHR 8021-0373-2; VAHR 8021-0374-2

Prior to the commencement of the activity the six Object Collections currently located within the extent of VAHR 8021-0374 must be excavated and relocated under the supervision of a heritage advisor and representatives of BLCAC. These object collections represent reburials of cultural material recovered during works conducted for CHMP 11342.

The object collection must be relocated by utilising the GPS coordinates contained on the VAHR Object Collection registration (**E:** 380971 **N:** 5765516 **Z:** 55) and mechanically excavating carefully to the necessary depth to reach the glass jar containing the artefacts.

The Object Collections must be relocated to a location agreed to by the RAP and the Sponsor within the activity area, and this location must be registered with the VAHR.

The Sponsor is responsible for meeting the costs of the relocation of the Object Collections.

Condition 9: Partial Salvage of VAHR 8021-0374

Prior to commencement of the activity a program of archaeological salvage must be completed in accordance with the BLCAC excavation procedures and the guidelines laid out in the FP-SR Practice Note for Salvage Excavations.

Salvage works must follow the salvage methodology presented below, and the cost of the salvage must be met by the Sponsor.

The salvage program must be supervised by an appropriately qualified archaeologist with experience conducting excavations in similar conditions.

The salvage program must consist of a total salvage area of 75 square metres, with 25 square metres (33%) of this total conducted by hand. The specific location and arrangement of the salvage trenches must be determined by the RAP Heritage Unit in consultation with the supervising archaeologist prior to salvage works commencing, however it is envisaged that the mechanical component of the salvage works will be undertaken in a linear manner across the rise that is the extent of VAHR 8021-0374 from north west to south east. Hand salvage pits will be located off the baseline created by the linear mechanical trench at locations informed by the mechanical salvage results and agreed to by the RAP Heritage Unit

Salvage areas must be expanded if any excavated spit within a square metre is found to contain more than 25 artefacts or an archaeological feature (such as a hearth, *in situ* knapping floor or faunal remains associated with an archaeological context), however any expansion must be drawn from the total 75 square metres required for the salvage program.

All archaeological features must be excavated by hand, and samples for OSL and/or radiocarbon dating must be taken for any such feature. Particle size analysis must also be undertaken for salvage trenches containing archaeological features. All excavated sediment from archaeological features must be sieved through a 3mm gauge mesh.

At the completion of all salvage works and associated analysis any recovered cultural material must be reburied at the same agreed location as the Object Collections discussed in Condition 6.

Condition 9.1: Mechanical Salvage Program Methodology

Of the total 75 square metres of salvage required, 50 square metres must be undertaken by machine across the activity area in a linear manner in order to aid in assessing the full depth of soil profile across a broader area and also identify any areas of higher artefact density. The specific location and configuration of the machine excavation salvage works must be developed in consultation with the RAP Heritage Unit. The mechanical excavation must be conducted in a linear transect of 100m in length, however due to the inherent OH&S issues associated with the excavation of sand deposits, the transects must be broken up into linear 5x1m trenches with intermittent bulks also measuring 5x1m, making a total of 50 square metres.

Mechanical excavation must proceed in the following manner:

a) All salvage trenches must be excavated in units no larger than 2m x 1m and in spits of a maximum depth of 100mm to ensure spatial integrity is maintained and to control the recovery of artefacts.

b) Machine excavation of each spit must be monitored by a suitably qualified and experienced archaeologist and/or RAP representative, and the contents of each spit must be fully sieved, prior to commencement of excavation of the next spit.

c) Excavation must occur until an archaeologically sterile base is located or to a maximum depth of 1,200mm (1.2m), whichever is first. In areas where an archaeologically sterile base is not encountered above 1,200mm, further excavation must be excavated by hand following the same methodology set out in 7.3 below. It is not necessary that the entire base of any such machine trench be excavated below 1.2m, just that an agreed sample of the deeper deposits be further investigated in this manner.

d) If an archaeological feature (such as a hearth, *in situ* knapping floor or faunal remains associated with an archaeological context) is identified, mechanical excavation must cease while the feature is defined and excavated using a trowel and recorded in accordance with proper archaeological practice and FP-SR guidelines if it is safe to do so. Once this has occurred mechanical excavation of the salvage trench may recommence.

e) All soils from each excavation trench must be sieved through a 5mm mesh and stockpiled as close as practicable to the excavation site. *In-situ* knapping deposits and sediments associated with defined features must be sieved through a 3mm mesh; and

f) The supervising archaeologist must ensure that all aspects of field recording are rigorously undertaken, including:

- GIS recording
- photography
- soil identification and testing
- collection of soil samples
- collection of charcoal or sand samples for dating
- stratigraphic recording
- artefact recording and labelling.

Condition 9.2: Manual Salvage Program Methodology

Of the total 75 square metres of salvage required, 25 square metres must be undertaken by hand within the extent of VAHR 8021-0374. The specific location of the hand excavation salvage works must be informed by the results of initial mechanical salvage and consultation with the RAP Heritage Unit, and it is intended that the mechanical trenches are utilised as a baseline from which to offset a series of initial 1m² pits before utilising the remaining square metreage for more refined and targeted salvage works.

The hand excavation component of the salvage works must proceed in the following manner:

a) Excavation must occur systematically in 1x1m excavation units (XUs) and in spits with a maximum depth of 50mm to ensure stratigraphic integrity is maintained and to control the recovery of artefacts.

b) Excavation must occur until either a sterile base is located or to a maximum safe working depth, whichever is first. If any hand excavated trench exceeds safe working depths (1,200mm or 1.2m) a 50cm² shovel test pit can be excavated below in the centre of the XU. This method has been developed in order to comply with OH&S practices and protect all participants in the salvage works.

c) All soils from the hand excavation must be sieved through a 5mm mesh and stockpiled as close as practicable to the excavation site. *In-situ* knapping deposits and sediments associated with defined features must be sieved through a 3mm mesh;

d) Spits are to be recorded in accordance with proper archaeological practice and FP-SR guidelines

e) *In situ* artefact locations must be recorded using a Total Station;

f) The supervising archaeologist must ensure that all aspects of field recording are rigorously undertaken, including:

1. GIS recording
2. photography
3. soil identification and testing
4. collection of soil samples
5. collection of charcoal or sand samples for dating
6. stratigraphic recording

7. artefact recording and labelling.

Condition 10: Preparation of Salvage Report for VAHR 8021-0374

Following the completion of salvage works a record edit must be submitted to, and verified by, the VAHR prior to the completion of the salvage report, even if no further Aboriginal cultural heritage was identified during the salvage. A report detailing the results of the salvage must also be completed. The salvage report must meet the standards outlined in the FP-SR Practice Note for Salvage Excavations. This report must provide a detailed analysis of any Aboriginal cultural heritage recovered and associated radiometric, Optically Stimulated Luminescence (OSL) or Thermoluminescence (TL) dating, if undertaken. The salvage report must be lodged with the VAHR and BLCAC within twelve months of completion of all salvage works, as well as lodgement of any additional data related to the analysis, including relevant spatial data.

The cost of production of this salvage report must be met by the Sponsor.

The salvage works and subsequent analysis aim to further expand on what is known about Aboriginal occupation of the activity area and the wider region. To assist in focusing the research the following questions will attempt to be addressed:

a) What can scientific dating, along with artefact analysis tell us about the age/s of occupation deposits over time?

b) Can a meaningful dated stratigraphy be identified for VAHR 8021-1374? If so, how can this inform us about use of the activity area and surrounds over time?

c) What activities occurred within the Aboriginal Place?

d) The salvage area is located on the edge of a sand dune and represents the edge of what once was a larger Aboriginal Place. Does the artefact assemblage or the spatial relationship of the artefacts reflect alternate uses for this part of the dune in comparison to what is known about utilisation of dune crests?

e) What can the salvage works tell us about the interface of the dune system with the surrounding landforms?

f) What do the raw materials this tell us about availability material use?

g) What resources were likely being exploited in the local area?

h) What landscape modification has occurred over time; how have processes like dune movement, geomorphological processes, pedoturbation and the effects of modern settlement impacted archaeological deposits in the area?

i) How does the Aboriginal cultural material from the activity area compare with known Aboriginal Places within the wider region? What can this tell us about Aboriginal use of the regional landscape?

Condition 11: Variations to the Salvage Methodology & Other Management Conditions

Should Occupational Health and Safety concerns or other practical issues arise during the salvage excavations, the location/orientation/layout of the salvage trenches and/or the salvage methodology may be altered in consultation between the Sponsor and RAP Heritage Unit, provided any alterations are agreed to in writing by the RAP.

Condition 12: Custody and Management of Artefacts from VAHR 8021-0374 and Object Collections VAHR 8021-0369-2; VAHR 8021-0370-2; VAHR 8021-0371-2; VAHR 8021-0372-2; VAHR 8021-0373-2; VAHR 8021-0374-2

This condition relates to the treatment of the Aboriginal cultural heritage from the VAHR registrations that occur within the activity area:

The Heritage Advisor must ensure that all Aboriginal cultural heritage (other than Aboriginal Ancestral Remains) recovered from the activity area either during the assessment phase of the CHMP or during subsequent salvage processes are managed in the following way:

1) A Heritage Advisor must fully document, package, and securely store all recovered cultural material until it is repatriated to the BLCAC.
2) A Heritage Advisor must submit all relevant documentation to the VAHR.
3) A Heritage Advisor may initially retain custody of the recovered cultural material for scientific analysis for a period of up to six months from the completion of the activity.
4) Within six months after the completion of the salvage works a Heritage Advisor must contact the BLCAC to arrange the repatriation and reburial of all cultural material recovered at the agreed location within the activity area.

The repatriation process must occur as follows:

1) All cultural material must be appropriately packaged in a durable container and sorted by archaeological context from which it was recovered.
2) The packaged cultural material must be accompanied by the relevant artefact catalogue as well as the nature, extent and significance statement for the associated place.
3) All relevant recording and documentation, including VAHR Place record edits must be undertaken by a Heritage Advisor.
4) All costs associated with the repatriation must be met by the Sponsor.

The reburial process must occur as follows:

1) Available space within the activity area must be set aside which is protected from future development or disturbance.
2) The location of the reburial area must be negotiated and agreed upon between the Sponsor and the BLCAC.
3) All cultural material must be appropriately packaged in a durable container and sorted by archaeological context from which it was recovered.
4) The packaged cultural material must be accompanied by the relevant artefact catalogue as well as the nature, extent and significance statement for the associated place.

5) The reburial of the cultural material must be conducted by the BLCAC Heritage Unit.
6) A smoking ceremony must be undertaken by a BLCAC representative during the reburial
7) All relevant recording and documentation, including VAHR place record edits must be undertaken by a Heritage Advisor.
8) All costs associated with the reburial must be met by the Sponsor.

2.0 Contingency Planning

2.1 Contingency 1: Proposed Changes to the Activity

The contingency plans presented in this section are specific to the activity area and the activity described within this CHMP. If, following the approval of this CHMP, changes to the activity or the activity area requiring statutory authorisation or which require any changes to the management conditions contained within the approved CHMP occur, the Sponsor may either apply to amend the approved CHMP or prepare a new CHMP which incorporates any changes.

2.2 Contingency 2: Matters Referred to in Section 61 of the Act

If Aboriginal cultural heritage is unexpectedly discovered during the activity, the Sponsor, where possible, must prioritise harm avoidance or harm minimisation to the Aboriginal cultural heritage. Harm avoidance or harm minimisation strategies must be implemented by the Sponsor or the relevant representative of the Sponsor in consultation with the BLCAC.

2.3 Contingency 3: Dispute Resolution Process

Procedures for dispute resolution aim to ensure that all parties are fully aware of their rights and obligations, that full and open communication between parties occurs and that those parties conduct themselves in good faith.

If a dispute arises that may affect the conduct of the activity, resolution between the parties using the following dispute resolution procedure is required:

1. All disputes will be jointly investigated and documented by both BLCAC and the Sponsor.
2. Where a breach of the CHMP conditions has been identified, and there is no agreement between the parties as to how that breach is to be remedied, BLCAC and the Sponsor must meet within one week of the initial notification of the breach to seek agreement as to a suitably appropriate remedial measure.
3. The Sponsor and the BLCAC must arrange for authorised representatives to be present at the meeting.
4. At the meeting, the authorised representatives of both BLCAC and the Sponsor must state their understanding of the issue(s) in dispute and ensure each party is aware of their position. If requested by either the relevant RAP or the Sponsor, third party mediation may be held during the meeting.
5. If the authorised representatives of the parties reach agreement, the agreed corrective method for the breach must be recorded in writing and signed by both parties (Agreed Method Statement). If the authorised representatives of the parties do not reach agreement, the parties will participate in third party mediation of the dispute by an agreed mediator within two weeks. Any costs of the mediation are to be met equally by the parties. Any agreed outcome of the mediation must be recorded in writing and signed by both parties (Agreed Method Statement).
6. The Sponsor, site supervisor, contractor and any relevant personnel will not undertake any correction or remedial activities except in accordance with the Agreed Method Statement. Any correction or remedial activities required must:
    i) Be recorded in writing and signed off by the authorised representatives of the BLCAC and Sponsor.

ii) Be supervised by a BLCAC representative.

iii) Occur in accordance with the instructions of the RAP representative, providing they are consistent with the agreed correction activities.

iv) The RAP will strive to minimise delays to work schedules while not compromising Aboriginal cultural heritage, places or values.

Issues related exclusively to cultural heritage management, which do not have an impact on the conduct of the activity, will be handled through the following dispute resolution mechanism:

1. Within one week of notification to each party that a breach is deemed to exist, authorised representatives of BLCAC and the Sponsor must attempt to negotiate a resolution to any dispute related to the cultural heritage management of the activity area within two working days.
2. If the authorised representatives of the BLCAC and the Sponsor do not reach agreement, the parties will participate in third party mediation of the dispute by an agreed mediator within two weeks. Any costs of the mediation are to be met equally by both parties. Any agreed outcome of the mediation must be recorded in writing and signed by both parties (Agreed Method Statement).

Regardless of the category of dispute, the dispute resolution process does not preclude:

1. The parties seeking advice from First Peoples-State Relations to assist in resolution of the dispute; and
2. Any legal recourse open to the parties being taken; however, the parties must agree that the above resolution mechanism will be implemented before such recourse is made.

For the purpose of dispute resolution, the following persons will represent the parties:

Sponsors Agent:
Contact Person: Kathy MacInnes
Telephone: (03) 9978 7823 | M 0437 401 554
Email: Kathy.MacInnes@ricardo.com

RAP:
Cultural Heritage Manager – Heritage Unit
Telephone: (03) 9770 1273
Email: submissions@bunuronglc.org.au

Any change in personnel appointed as authorised representatives in one party will be notified promptly to all parties.

2.4 Contingency 4: Management of Aboriginal Cultural Heritage Found During the Activity

Discovery of Human Remains

If any suspected human remains are found during any activity, works must cease. The Victoria Police and the State Coroner's Office must be notified immediately. If there are reasonable grounds to believe the remains are Aboriginal, the Coronial Admissions and Enquiries hotline must be contacted immediately on 1300 309 519. This advice has been developed further and is described in the following 5-step contingency plan. Any such discovery at the activity area must follow these steps.

1) Discovery:

a) If suspected human remains are discovered, all activity must stop.

b) The remains must be left in place and protected from harm or damage.

c) Do not contact the media; do not take any photographs of the remains other than those requested by the relevant authorities below.

2) Notification:

a) If suspected human remains have been found, the State Coroner's Office and the Victoria Police must be notified immediately.

b) If there are reasonable grounds to believe the remains are Aboriginal Ancestral Remains, the Coronial Admissions and Enquiries hotline must be immediately notified on 1300 309 519.

c) All details of the location and nature of the human remains must be provided to the relevant authorities.

d) If it is confirmed by State Coroner's Office that the discovered remains are Aboriginal Ancestral Remains, the person responsible for the activity must report the existence of them to the Victorian Aboriginal Heritage Council in accordance with Section 17 of the *Aboriginal Heritage Act 2006*.

3) Impact Mitigation or Salvage:

a) The Victorian Aboriginal Heritage Council, after taking reasonable steps to consult with any Aboriginal person or body with an interest in the Aboriginal Ancestral Remains, will determine the appropriate course of action as required by Section 18(2)(b) of the *Aboriginal Heritage Act 2006*.

b) An appropriate impact mitigation or salvage strategy as determined by the Victorian Aboriginal Heritage Council must be implemented by the Sponsor. All costs associated with this will be the responsibility of the Sponsor.

4) Curation and further analysis:

a) The treatment of salvaged Aboriginal Ancestral Remains must be in accordance with the direction of the Victorian Aboriginal Heritage Council.

5) Reburial:

a) Any reburial site(s) must be fully documented by an experienced and qualified archaeologist and all relevant details provided to the Registrar.

b) Appropriate management measures must be implemented to ensure the Aboriginal Ancestral Remains are not disturbed in the future.

Discovery of Low Density Artefact Distributions

If a low density artefact distribution (10 or fewer stone artefacts within a 10 m x 10 m area) is discovered during the activity, the following measures must be undertaken:

1) The person in charge of the activity must notify both the BLCAC and a Heritage Advisor of the suspected Aboriginal cultural heritage within one business day of the discovery. The person in charge of the works at the time of the discovery is deemed to be the person who discovered the Aboriginal cultural heritage place or object(s).

2) All works must cease within 10 m of the discovery area, and all personnel contracted to undertake the activity must be notified of the suspected discovery.

3) The suspected Aboriginal cultural heritage must be cordoned off by a suitable barrier (e.g. safety barrier mesh, temporary fencing, or flagging tape) and remain in place until it has been assessed by the BLCAC and a Heritage Advisor.

4) A Heritage Advisor must facilitate the participation of the BLCAC in the assessment of the Aboriginal cultural heritage.

5) A Heritage Advisor and a BLCAC representative must inspect the suspected Aboriginal cultural heritage as soon as practicable and within a maximum of five business days of the notification of the discovery.

6) A Heritage Advisor, in consultation with the BLCAC, must identify the extent, nature and significance of the Aboriginal cultural heritage material in the activity area.

7) The Sponsor, a Heritage Advisor and the BLCAC must discuss opportunities of avoiding and minimising harm to the Aboriginal cultural heritage. The Sponsor must attempt to avoid or minimise harm to the Aboriginal cultural heritage as the first priority.

8) Where harm cannot be avoided or minimised, a qualified archaeologist in consultation with the BLCAC must salvage the Aboriginal cultural heritage material. The salvage must involve the recording, collection (labelled and packaged according to provenance), and analysis of the Aboriginal cultural heritage. The Aboriginal cultural heritage must be recorded with the use of a DGPS (with <1 m accuracy).

9) A Heritage Advisor within three weeks of the salvage and associated analysis must submit any required VAHR place record edits or new place registrations.

10) All costs associated with the procedures specified in this contingency must be organised and paid for by the Sponsor.

11) The activity may recommence within the 10 m exclusion area once:
   a) All the procedures specified above have been followed; and
   b) No dispute occurs as to the course of action(s) required.

Discovery of Artefact Scatters, Stratified Deposits and/or Cultural Features

If artefact scatters, stratified deposits, and/or other cultural heritage features are discovered during the activity, then the following measures must be undertaken:

1) The person in charge of the activity must notify both the BLCAC and a Heritage Advisor of the suspected Aboriginal cultural heritage within one business day of if its discovery. The person in charge of the works at the time of the discovery is deemed to be the person who discovered the Aboriginal cultural heritage place or object(s).

2) All works must cease within 10 m of the discovery area, and all personnel contracted to undertake the activity must be notified of the suspected discovery.

3) The suspected Aboriginal cultural heritage must be cordoned by a suitable barrier (e.g. safety barrier mesh, temporary fencing, or flagging tape) and remain in place until it has been assessed by the BLCAC and a Heritage Advisor.

4) A Heritage Advisor must facilitate the participation of the BLCAC in the assessment of the Aboriginal cultural heritage.

5) A Heritage Advisor and a BLCAC representative must inspect the suspected Aboriginal cultural heritage as soon as practicable and within a maximum of five business days of the notification of the discovery.

6) A Heritage Advisor, in consultation with the BLCAC, must identify the extent, nature and significance of the Aboriginal cultural heritage material in the activity area.

7) The Sponsor, a Heritage Advisor and the BLCAC must discuss opportunities of avoiding and minimising harm to the Aboriginal cultural heritage. The Sponsor must avoid or minimise harm to the Aboriginal cultural heritage as the first priority.

8) Where harm cannot be avoided or minimised, and the identified Aboriginal cultural heritage is suitable for salvage excavation, then this must be undertaken by a qualified archaeologist in consultation with the BLCAC. The purpose of the salvage is to establish the extent, nature, and significance of the Aboriginal Place. A DGPS (with <1 m accuracy) must be used when mapping the cultural material and features. Any salvage methodology must be approved by the BLCAC. The objectives of the salvage must establish, but are not limited to:

   a) The stratigraphy, with an emphasis of where the Aboriginal cultural heritage material was found (e.g. the context of the stratigraphic layer);

b) The chronological sequence (if possible) of the Aboriginal cultural heritage material, features, and/or remains;

c) The composition and characteristics of the Aboriginal cultural heritage; and

d) Whether there is any spatial variability or patterning of the Aboriginal cultural heritage investigated.

9) If the Aboriginal archaeological remains are assessed as being in-situ, appropriate age determinations to establish the age of the Aboriginal heritage must include Optically Stimulated Luminescence (OSL) when sufficient organic samples cannot be obtained for radiocarbon analysis (Carbon 14 dating). All Aboriginal cultural heritage material recovered from the activity area must be stored by a Heritage Advisor until the salvage excavation has been concluded.

10) A Heritage Advisor within three weeks of the salvage and associated analysis must submit any required VAHR place record edits or new place registrations.

11) The salvage excavation must be supervised by a person appropriately qualified in archaeology and be undertaken in accordance with Regulation 65(3-7) of the *Aboriginal Heritage Regulations 2018*, and the FP-SR Practice Note on Salvage Excavations.

12) A Heritage Advisor must lodge the final salvage report to the BLCAC and the VAHR no later than six months after the completion of the salvage excavation and analysis.

13) All costs associated with the procedures specified in this contingency must be organised and paid for by the Sponsor.

14) The activity may recommence within the 10 m exclusion area once:

a) All the procedures specified above have been followed; and
b) No dispute occurs as to the course of action(s) required.

2.5 Contingency 5: Removal, Custody, Curation and Management of Aboriginal Cultural Heritage During the Activity

A Heritage Advisor must ensure that all Aboriginal cultural heritage (other than Aboriginal Ancestral Remains) recovered from the activity area either during the assessment phase of the CHMP or during subsequent salvage processes are managed in the following way:

1) The heritage advisor must fully document, package, and securely store all recovered cultural material until it is repatriated to the BLCAC.
2) The heritage advisor must submit all relevant documentation to the VAHR.
3) The heritage advisor may initially retain custody of the recovered cultural material for scientific analysis for a period of up to six months from the completion of the activity

4) Within six months after the completion of the salvage works the heritage advisor must contact the relevant RAP to arrange the repatriation of all cultural material at the agreed location within the activity area.
5) Any cultural material recovered during the conduct of the activity must be repatriated to BLCAC by the heritage advisor or Sponsor within three weeks of its recovery.

Upon completion of the activity, the heritage advisor must repatriate all recovered cultural material to BLCAC. The repatriation process must occur as follows:

1) All cultural material must be appropriately packaged in a durable container and sorted by archaeological context from which it was recovered.
2) The packaged cultural material must be accompanied by the relevant artefact catalogue as well as the nature, extent and significance statement for the associated Place.
3) All relevant recording and documentation, including submission of object collection forms to the VAHR, must be undertaken by a heritage advisor.
4) All costs associated with the repatriation must be borne by the Sponsor.

Following the repatriation of the recovered cultural material to the BLCAC, should BLCAC wish to rebury the recovered cultural material the following must occur:

1) Available space within the activity area must be set aside which is protected from future development or disturbance.
2) The location of the reburial area must be negotiated and agreed upon between the Sponsor and the BLCAC.
3) All cultural material must be appropriately packaged in a durable container and sorted by archaeological context from which it was recovered.
4) The packaged cultural material must be accompanied by the relevant artefact catalogue as well as the nature, extent and significance statement for the associated Place.
5) The reburial of the cultural material must be conducted by a BLCAC representative and RAP heritage advisor.
6) A smoking ceremony must be undertaken by a BLCAC representative during the reburial.
7) All relevant recording and documentation, including submission of Place Record Edits to the VAHR, must be undertaken by a heritage advisor.
8) All costs associated with the reburial must be borne by the Sponsor.

2.6 Contingency 6: Reviewing Compliance and Mechanisms for Remedying Non-compliance with the CHMP

The Sponsor or nominated representative is responsible for remedying non-compliance with this CHMP. In the event that the conditions or contingencies set out in this CHMP are not adhered to, all works must cease, and the relevant RAP contacted immediately. A record of the breach must be documented, and immediate action taken to remedy the breach, under the direction of the relevant RAP. The record of the breach must include the reasons for non-compliance. The Sponsor or nominated representative must take immediate action to remedy non-compliance in accordance with the relevant condition or contingency. All acts of non-compliance must be reported to both the BLCAC and First Peoples-State Relations, which may result in an investigation by an Authorised Officer or Aboriginal Heritage Officer. A record of CHMP compliance must also be maintained by the Sponsor or nominated representative at all times and must be available for inspection by either an Authorised Officer or Aboriginal Heritage Officer under the *Aboriginal Heritage Act 2006* or any other representative of the BLCAC or First Peoples-State Relations.

Contingency Table 1: Checklist for reviewing compliance with CHMP 17359*

CHECKLIST FOR REVIEWING COMPLIANCE WITH THIS CHMP		
	Yes /No	**If No…**
Ensuring compliance		
Prior to works –		
1: Is a copy of the approved CHMP available on-site in accordance with General Condition 1? Is the approved CHMP accessible to all project staff in accordance with General Condition 1?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
2: Has a cultural heritage induction taken place in accordance with General Condition 2?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
4: Has the Aboriginal Cultural Heritage Place Yannathan AS 6 (VAHR 8021-0374) been subject to an archaeological salvage excavation in accordance with Specific Condition 7?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
5: Has an inspection of the archaeological salvage excavation of the Aboriginal Cultural Heritage Place Yannathan AS 6 (VAHR 8021-0374) been subject to an archaeological salvage excavation in accordance with General Condition 4?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
During works –		
1: Is a copy of the approved CHMP available on-site in accordance with General Condition 1? Is the approved CHMP accessible to all project staff in accordance with General Condition 1?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
2: Has the protocol for handling sensitive information been complied with in accordance with General Condition 3?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
3: Has the Sponsor or site supervisor ensured that the activity adheres to the activity description as detailed in Section 5 of the CHMP?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
After works –		
1: Has the custody and management of Aboriginal cultural heritage been undertaken in accordance with Specific Condition 10?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.

2: Has the salvage report been completed in accordance with Specific Condition 8 and sought to address the research questions posed in that Condition?		All works within the activity area for this CHMP must immediately cease and the BLCAC be contacted immediately.
Contingency Plans for Discovery of Aboriginal Heritage During Works		
1: If suspected human remains have been identified, have all works immediately ceased and the Coroner, the VAHC and the BLCAC been contacted as per the 5-step contingency plan in Contingency 5?		All works within the activity area for this CHMP must immediately cease and the BLCAC and authorities be contacted immediately. Refer to Contingency 5.
2: If potential Aboriginal cultural heritage has been discovered, has the correct procedure been followed as per Contingency 5?		All works within the activity area for this CHMP must immediately cease within a 10m buffer of the suspected heritage and the BLCAC be contacted immediately. Refer to Contingency 5.
Management of Aboriginal Cultural Heritage Identified During Works		
1: Has the procedure been followed for management of Aboriginal Cultural Heritage identified during works as per Contingency 5?		Refer to Contingency 5.

*Review of this CHMP can be undertaken at any time by project delegates representing the Sponsor, or by an agreed independent reviewer to ensure that all parties are complying with the terms of this CHMP.

3.0 Communication

The Sponsor and any personnel involved with supervision of future construction must read the CHMP and be aware of the legal requirements and contingency procedures concerning Aboriginal cultural heritage within the activity area. The Sponsor must be responsible for implementing any conditions contained in the CHMP.

The Sponsor must set in place internal processes of communication to ensure that they are notified prior to any contractors conducting works (including archaeological contractors) at any of the archaeological sites on the property.

<u>Contact Details</u>

The Sponsor or Sponsor's Agent

Company Name: Hanson Construction Materials
Attn: Gunther Benedek

Telephone: (03) 5997 8109 | M 0409 256 503
Email: gunther.benedek@hanson.com.au

Bunurong Land Council Aboriginal Corporation

Cultural Heritage Manager – Heritage Unit
Bunurong Land Council Aboriginal Corporation

Telephone: (03) 9770 1273
Email: submissions@bunuronglc.org.au

First Peoples-State Relations

GPO 2392
Melbourne VIC 3001

Phone: 1800 762 003
Email: aboriginal.heritage@dpc.vic.gov.au

Victorian Aboriginal Heritage Council

GPO Box 2392
Melbourne VIC 3001

Phone: (03) 8392 5392
Email: vahc@dpc.vic.gov.au

Part Two: Assessment

4.0 Introduction

4.1 Reasons for Preparing a Cultural Heritage Management Plan

This Cultural Heritage Management Plan (CHMP) has been undertaken at the request of the Sponsor, Hanson Construction Materials Pty Ltd, for a proposed expansion of the extraction area at Yannathan Quarry. A CHMP is a mandatory requirement for the proposed activity because:

> all or part of the activity area is an area of cultural heritage sensitivity (*Aboriginal Heritage Regulations 2018*, Division 1, 7(a)); and
>
> the proposed activity is a high impact activity (*Aboriginal Heritage Regulations 2018*, Division 1, 7(b)).

The proposed activity area is considered an area of cultural heritage sensitivity because the activity area is located within dune landform (r.40) and within 50m of registered Aboriginal Places (r.25). Previously registered Aboriginal Places VAHR 8021-0369, VAHR 8021-0370, VAHR 8021-0373 and VAHR 8021-0374 are located within the current activity area. Also located within the activity area are object collection components associated with VAHR 8021-0369, VAHR 8021-0370, VAHR 8021-0371, VAHR 8021-0372, VAHR 8021-0373 and VAHR 8021-0374 which have been reburied within the activity area (within the site boundary of VAHR 8021-0374).

Registered cultural heritage places (r.25)

> (1) A registered cultural heritage place is an area of cultural heritage sensitivity.
>
> (2) Subject to subregulation (3), land within 50 metres of a registered cultural heritage place is an area of cultural heritage sensitivity.

Dunes (r.40)

> (1) Subject to subregulation (2), a dune or a source bordering dune is an area of cultural heritage sensitivity.

The proposed activity is considered a high impact activity as it is for the extraction of sand and requires an earth resource authorisation (r.51).

Activities requiring earth resource authorisations (r.51)

An activity is a high impact activity if it is an activity—

> (a) for which an earth resource authorisation is required before the activity may be carried out; and
>
> (b) that would result in significant ground disturbance.

This is a medium sized activity area and the CHMP has been completed to the level of complex assessment.

4.2 Sponsor for the Cultural Heritage Management Plan

The Sponsor for this CHMP is Hanson Construction Materials Pty Ltd (ABN 90 009 679 734).

4.3 Notice of Intent to Prepare a CHMP

In accordance with Section 54(1) of the *Aboriginal Heritage Act 2006*, a Notice of Intent to Prepare a CHMP (NOI; Appendix 1) was submitted on July 29, 2020 to First Peoples-State Relations (FP-SR). FP-SR replied to the NOI on July 29, 2020 and allocated the project number 17359. A copy of the NOI was also provided to the Registered Aboriginal Party (RAP) on July 29, 2020 and to the Cardinia Shire Council on August 14, 2020.

4.4 Name, Qualifications and Experience of Heritage Advisor

The heritage advisors and authors who conducted this CHMP are Renee McAlister, Simon Coxe, Lana Tranter-Edwards and Bianca Di Fazio.

Bianca Di Fazio holds formal qualifications in Australian archaeology (BA Hons Archaeology, 2000) from Flinders University; and the conservation of cultural material (MA Material Cultural Conservation) from the University of Melbourne (2010). Ms Di Fazio has over 20 years' experience in the conduct of a wide range of heritage management projects in south eastern Australia.

Renee McAlister has a BA (Hons) Archaeology from La Trobe University, Victoria (2010) and over ten years' experience working in the field of historical and Aboriginal archaeology.

Simon Coxe BA (Hons) is a senior project archaeologist and registered heritage advisor. Simon is also a PhD candidate at Monash University and an affiliate member of the Evolution of Cultural Diversity Initiative at Australian National University, Canberra. Simon holds formal qualifications in archaeology and has 16 years' experience conducting a broad range of heritage management and research projects throughout the UK and Australia, with experience working in Queensland (including Torres Strait), Western Australia, the Northern Territory, New South Wales and Victoria. He has also been involved in projects in Papua New Guinea, having conducted research fieldwork in Milne Bay, Caution Bay and the Simbai and Kaironk Valleys (Western Highlands). Simon specialises in the management of complex projects involving large field teams and complex datasets, as well as projects associated with the renewable energy sector.

Lana Tranter-Edwards (Hons) is a technical archaeologist with qualifications and experience in both Aboriginal and historic archaeology in Victoria. Lana's roles have incorporated fieldwork responsibilities, desktop research, cultural material analysis, GIS mapping and data compilation. Lana has also taken part in fieldwork in Victoria, Tasmania, New South Wales and Nepal with responsibilities including the management of spatial and geophysical survey and analysis, section illustration, excavation, recording oral history, stone artefact cataloguing and analysis, research assistance and remote fieldwork planning.

4.5 Location of the Activity Area

The activity area is located at 870-910 Westernport Road, Yannathan, 80km south east of Melbourne. The activity area is approximately 30.3ha (Map 1).

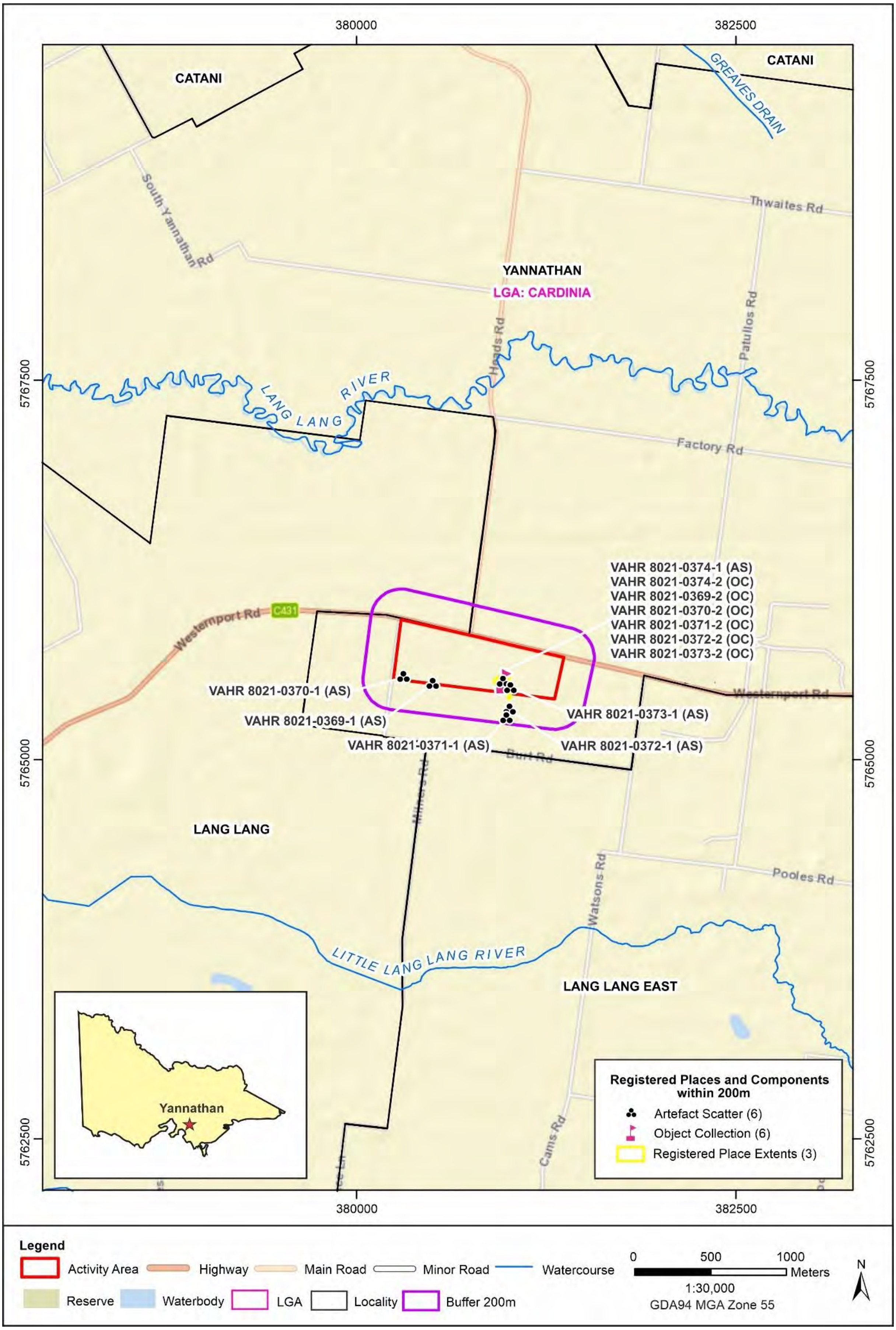
Cadastral details: 100B, PP2969, 39B\PP2969, Parish of Lang Lang East, Shire of Cardinia.

4.6 Landowners

The activity area is owned by Hanson Construction Materials Pty Ltd.

4.7 RAPs with Responsibility for the Activity Area

The Registered Aboriginal Party (RAP) for the activity area is the Bunurong Land Council Aboriginal Corporation (BLCAC). The BLCAC provided written confirmation that they intend to evaluate the CHMP (Appendix 2) on July 30, 2020.



Map 1: Location of the activity area – Shire of Cardinia

5.0 The Activity Area and Proposed Works

5.1 Extent of the Activity Area Covered by the Management Plan

The activity area is farmland currently used for grazing and is located at Yannathan, approximately 80 kilometres south east of Melbourne. The activity area comprises approximately 30.3 hectares and is bound to the north both by Westernport Road and farmland, to the east and west by farmland, and to the south by the main quarry area. The north eastern part activity area was recently used for the grazing of cattle; the rest of the activity area is not being currently being used for any purpose (Map 2).

5.2 Activity Description

The proposed activity is the extraction of sand, as an expansion of the sand extraction works currently being undertaken to the south of the activity area (permitted by approved CHMP 11342 (Maps 2 and 3).

The following activity description has been provided by the Sponsor's agent:

The proposed quarry will include processing of the extracted sand at the existing processing plant. The site will be extracted progressively, so that when one part of the site is being prepared for extraction (pre-quarrying phase) another part of the site will be extracted (operational phase) and yet another is being rehabilitated (rehabilitation phase). This will ensure rehabilitation is managed progressively as the site is worked.

During the pre-quarrying phase surface soils and overburden will be removed and stockpiled for use in future rehabilitation. Work will be done using a dozer, an excavator and a dump truck to move the soil and overburden to the stockpiles which will be placed around the perimeter of the quarry pit.

Sand extraction will be undertaken using a mix of quarry methods. Above the water table sand will be extracted using scrapers and excavators, placing the unprocessed sand into dump trucks for transport to the processing plant. Once the sand extraction has moved a distance below the water table a suction dredge will be floated. Sand will be extracted by the dredge.

The depth of the quarry and extension is proposed to extend to RL -9mAHD. Currently the base is a RL 9mAHD – extending by a further 18m.

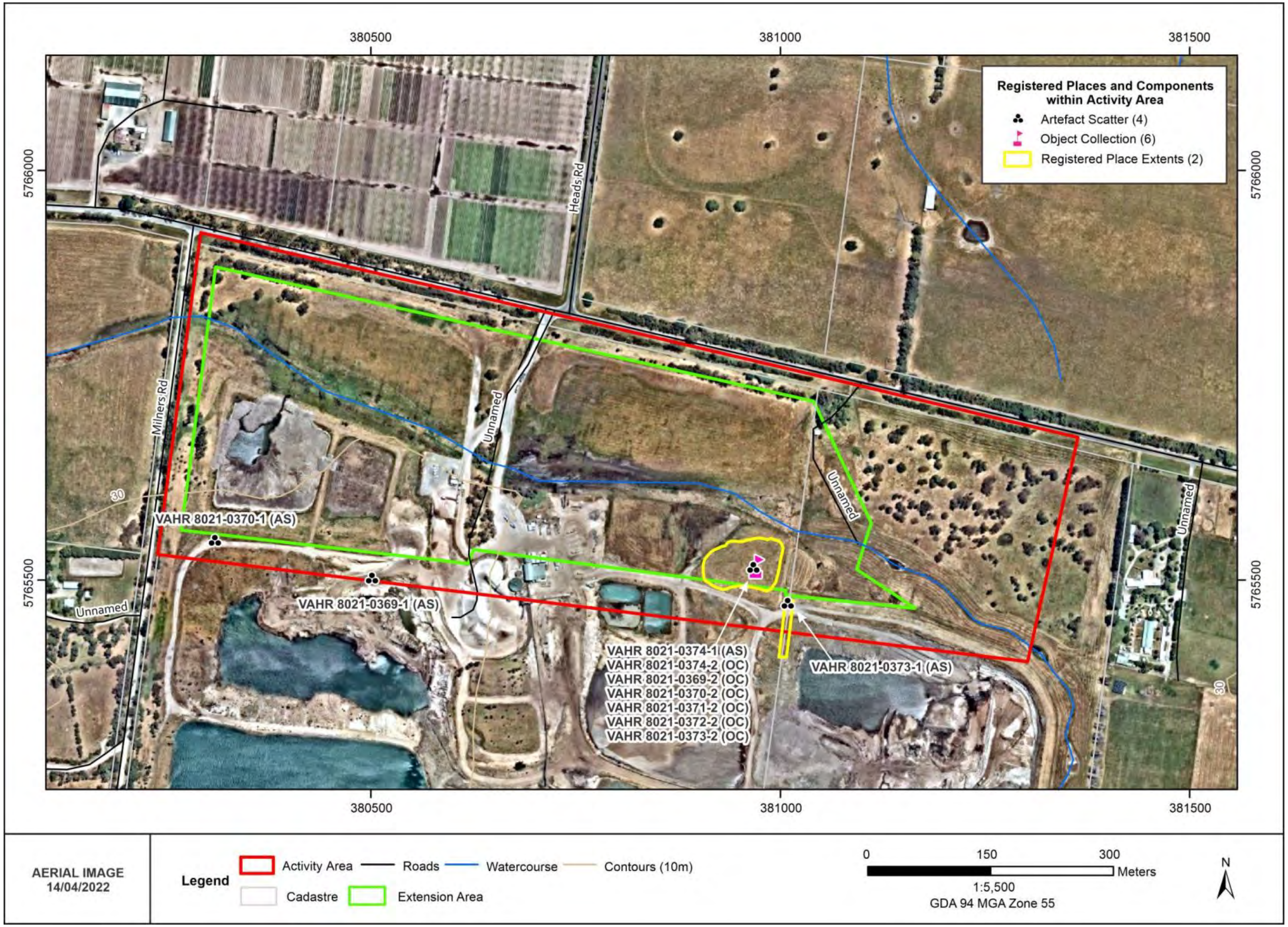
Rehabilitation of the site will by sympathetic to the surrounding natural environment. The final landform will comprise a large waterbody with landscaped margins and a central rehabilitated land area.

The proposal includes relocating cultural heritage material to an area on the perimeter of the site which will be designated for this purpose, as well as realignment of the drainage line which passes through the activity area (Map 3). The realigned waterway will be within the footprint of the quarry, and it is proposed to extract the sand from the area north of the current waterway, refill this area then construct the new waterway over the filled land.

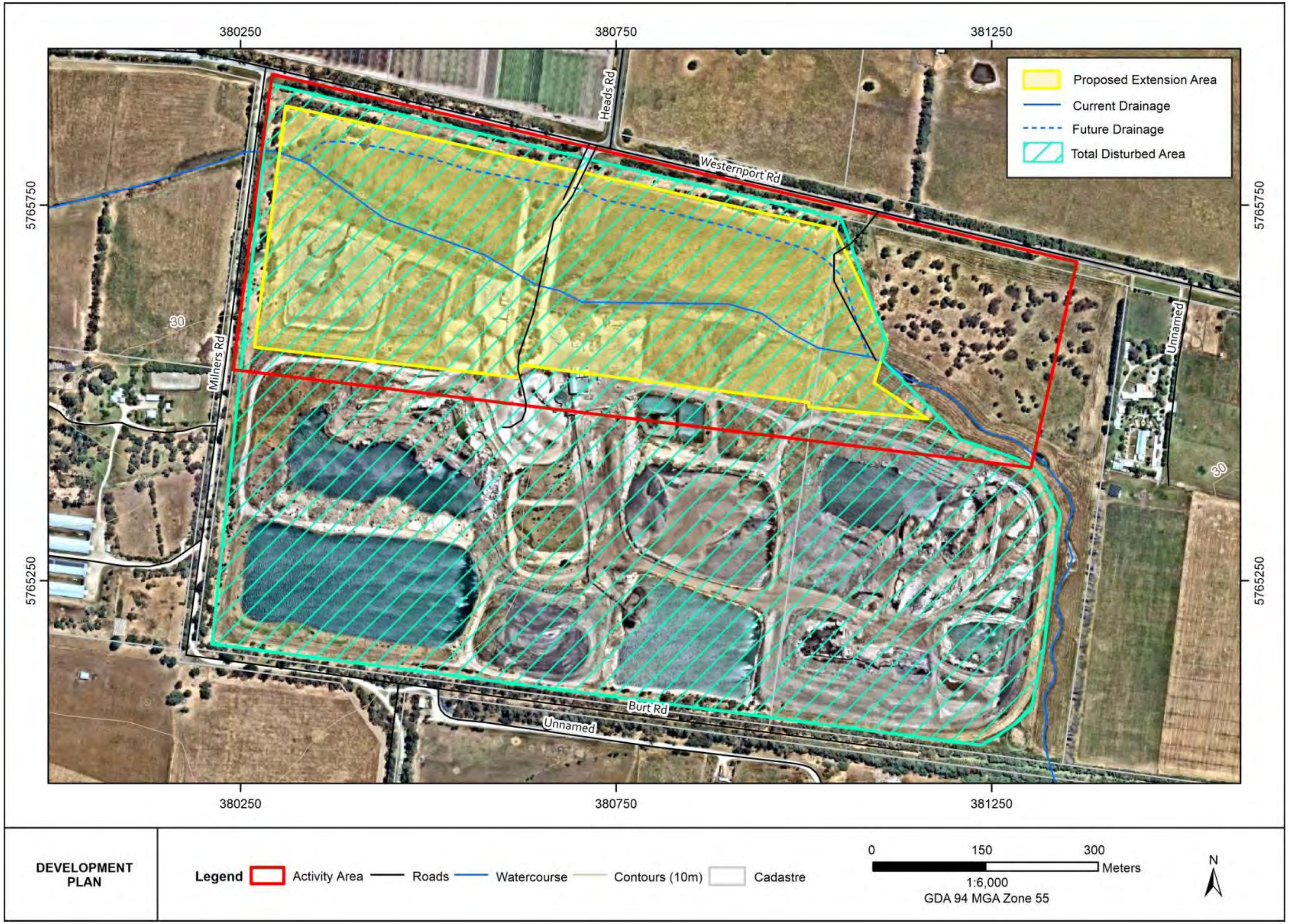
5.3 Statement of Potential Impacts

The proposed activities outlined above will involve soil disturbance to both surface and buried land surfaces. Excavation will be required across the entire activity area. Activities which will occur during the course of the proposed works are:

- Stripping/removing topsoil and overburden, utilising heavy machinery. The topsoil and overburden will be stockpiled for later use in rehabilitation or engineering works;
- Extraction and removal of sand to the on-site processing plant. Extraction will be undertaken using excavators and trucks. If needed, a dredge may also be used;
- Realignment of the current drainage line into overfilled land; and
- Following extraction, the site will be rehabilitated into a deep waterbody and future conservation area.



Map 2: Aerial image showing the current (14/04/2022) conditions in the activity area



Map 3: Indicative Works Plan

6.0 Documentation of Consultation

A Notice of Intent to Prepare a CHMP (NOI; Appendix 1) was submitted to the FP-SR pursuant to Section 54 of the *Aboriginal Heritage Act 2006* on July 29, 2020. A notice of acceptance was received from the FP-SR on July 29, 2020, allocating the project number 17359. A copy of the NOI was also provided to the Bunurong Land Council Aboriginal Corporation (BLCAC) on July 29, 2020. The BLCAC provided written confirmation on July 30, 2020 that they had elected to evaluate the CHMP (Appendix 2) pursuant to Section 55 of the *Aboriginal Heritage Act 2006*.

6.1 Participation in the Conduct of the Assessment

The standard assessment was conducted on April 22, 2021 by Renee McAlister and Simon Coxe (Heritage Insight), assisted by Iris Pepper and Wayne Pepper (BLCAC). The complex assessment was conducted between September 7 and November 16 2021 by Simon Coxe, Paul Chalice and Nick Stebbins (Heritage Insight Pty Ltd), assisted by Iris Pepper and Wayne Pepper, Minta Franks and Richard Cole (BLCAC).

6.2 Consultation in Relation to the Assessment

A project inception meeting was held on September 8, 2020 between Renee McAlister (Heritage Insight Pty Ltd), Robert Ogden (Heritage Manager – BLCAC), Elizabeth Toohey (Heritage Advisor – BLCAC), Kathy MacInnes (Ricardo) and Gunther Benedek (Hanson Construction Materials Pty Ltd). At this meeting, the results of the desktop assessment were presented. The results and conclusions of the previous CHMP 11342, encompassing this activity area, were presented. The proposed activity is expansion of the existing quarry into the north. It was noted that the previous management conditions allowed for the protection of a smaller sandy rise. Robert Ogden noted that having a small sandy rise retained and surrounded by a quarried out area was problematic, both from a safety and engineering perspective. It was agreed that further discussions could be undertaken about the possibility of not retaining this rise.

It was noted that quarry site occupies a former large dune landform that would have overlooked Koo Wee Rup Swamp and that during the original assessment, low densities of stone artefacts were located around the edge of that dune land form. The Sponsor now proposed to extend the quarry extraction area north into the landform identified as an alluvial swampy plain. This area was identified as an area of low archaeological potential during the original assessment. Geological mapping notes that the deeper sandy deposits under the alluvial plain likely represent Tertiary deposits and therefore substantially pre-date human occupation in Australia. Robert Ogden noted that during a recent CHMP assessment nearby some artefacts had been identified under a clay cap and so there was a lack of clarity around what constituted sterile deposits. It was agreed that more information was needed. Kathy MacInnes and Gunther Benedek agreed to review previous data that had been collected (for example, bore hole logs) and assess if additional geotechnical testing was required.

It was agreed that a standard assessment would be conducted. The standard assessment would provide updated information and could also assess the condition of the heritage protected area. If additional geotechnical testing was required, this could occur in conjunction with the standard assessment to allow for a greater understanding of the subsurface stratigraphy. This geotechnical data, bore log data and the results of the standard assessment would then inform any complex assessment methodology.

The standard assessment results meeting was held on May 6, 2021 between Renee McAlister (Heritage Insight Pty Ltd), Robert Ogden (Heritage Manager – BLCAC), Bradley Ward, Meg Haas (Heritage Advisors

– BLCAC), Kathy MacInnes (Ricardo) and Gunther Benedek (Hanson Construction Materials Pty Ltd). At the meeting it was noted that the activity area mostly comprised low-lying alluvial plain, the exception being the protected heritage zone which is a low sandy rise. It was considered likely that this area contained low archaeological potential, however, given that it was still located on swamp margins, some potential for the presence of cultural heritage remained. It was noted that minimal testing was conducted north of the drainage line during CHMP 11342. It was agreed that a complex assessment methodology comprising a series of 2x1m MTs north of the drainage line and one TP would be appropriate. Kathy MacInnes noted that there were still issues with water that could require a change of activity area. The issue of the sandy rise was also discussed and the potential to move the buried cultural material (Object Collections VAHR 8021-0369, VAHR 8021-0370, VAHR 8021-0371, VAHR 8021-0372, VAHR 8021-0373 and VAHR 8021-0374) to the conservation area north of the creek. This would also require a change of activity area. It was requested that a copy of the standard assessment map and a proposed complex assessment testing map be provided to the BLCAC for review. This map was provided via email on July 9, 2021

During the course of the complex assessment ground conditions were problematic for excavations due to heavy rainfall. As such, a number of test locations were unable to be targeted. This included the 1x1m test pit targeting the alluvial plain landform. Bradley Ward (BLCAC) was contacted on November 15 by Simon Coxe (Heritage Insight) and advised of the situation. It was agreed that given the nature of the ground conditions and the data obtained from numerous machine test pits (MTPs) excavated on the alluvial plain the requirement to excavate the 1x1m test pit could be waived.

The complex assessment results meeting was held on January 12, 2022, between Simon Coxe and Bianca Di Fazio (Heritage Insight Pty Ltd), Bradley Ward, Renee McAlister, Kathy MacInnes (Riccardo) and Gunther Benedek (Hanson Construction Materials Pty Ltd). The results of the complex assessment were discussed. It was noted that due to the low-lying nature of the landforms within the activity area, much of the area under investigation was prone to waterlogging after several days and weeks of heavy rain. The constraints on excavations and field discussion with Bradley Ward regarding the lack of the 1x1m test pit were reiterated. It was noted that no artefacts were recovered during the complex assessment. The reason for this, as suggested by Simon Coxe, was that these areas were less frequently utilised by Aboriginal peoples in the past due to the same issues with inundation and waterlogging within a swamp context. The results of the previous CHMP (11342) were also discussed, as the model of occupation developed by Barker and McAlister (2012) was reinforced by the results of the current complex assessment. Bradley Ward and Renee McAlister agreed with the assertion that the sandy rise that constitutes Yannathan AS 6 (VAHR 8021-0374) provided a stronger strategic focus for Aboriginal people in the past as it is located on higher ground above the flood zone/water table (alluvial plain and prior channels).

6.3 Consultation in Relation to the Conditions

Yannathan AS 6 (VAHR 8021-0374) and proposed impacts to the Place were discussed further as, due to the requirements of the proposed activity (sand extraction), harm to the Place cannot be avoided. Discussions turned to salvage methodologies and retrieval of reburied artefacts (previously excavated as part of CHMP 11342). It was agreed that salvage must occur and all artefacts be removed and reburied. The location and depth of the previously reburied artefacts were considered in light of quarry extraction scheduled to destroy the registered Place; the artefacts were reburied in glass jar in the centre of rise by Renee McAlister with Gunther Benedek (Hansons Pty Ltd) present. It was stated by both Renee McAlister and Gunther Benedek that the exact depth and location were unknown. BLCAC stipulated that salvage of Yannathan AS 6 (VAHR 8021-0374) must occur before sand extraction starts in that part of the activity area. Kathy MacInnes noted that a process of staged sand extraction starting elsewhere within the activity area and away from the Place would allow salvage excavations of the Place to be instigated while the activity commenced. At the request of the BLCAC, Heritage Insight agreed to put forward a proposal for salvage, such as a trench bisecting the rise to inform areas of density and then targeting these areas for further investigation and salvage; and an artefact threshold. The presence of hearths or bones would also to be used to trigger extension of works if present. The presence and depth coffee rock identified during excavations for CHMP 11342 was discussed, specifically where a culturally sterile basal clay lies in stratigraphic in relation to the coffee rock. It was agreed that geotechnical logs would be used to inform depth of base when considering salvage of the Place.

Bradley Ward stated that specific conditions must be written for the removal of the buried artefacts but that otherwise the BLCAC standard conditions for reburial could be implemented. Reburial of the artefacts within a new reserve area in the north eastern part of the activity area was proposed. Interpretive signage would be erected at the reburial location. The BLCAC considers this to be an open condition and the client will arrange a meeting with BLCAC discuss the nature of information to be included on the signage.

It was agreed that draft conditions would be sent to the BLCAC for review prior to lodgement of the completed CHMP.

A final meeting to discuss the management conditions was held on September 27, 2022 attended by Meg Haas, Dr Fleur King and Renee McAlister (BLCAC), Kathy MacInnes & Gunther Benedek representing the Sponsor, and Bianca Di Fazio (Heritage Insight). The management conditions were once again discussed, and Kathy MacInnes and Gunther Benedek raised the question of whether it would be possible to change the proposed reburial location from the north eastern corner of the activity area to the norther western corner. The RAP said that this would need to be discussed internally before it could be agreed, and Bianca agreed to provide the final recommendations for comment in the meantime.

The management conditions were provided by email to the RAP on October 25, 2022 and a response was received from them the next day. The RAP's comments have been incorporated into the management conditions contained in Part One of this CHMP.

6.4 Summary Outcomes of Consultation

The consultation undertaken throughout the CHMP process resulted in the following principal management conditions for the CHMP:

- Cultural heritage induction.
- Copy of the approved CHMP is kept on-site at all times during the activity.
- Two RAP inspections.
- Development of an interpretive strategy.
- No high impacts permitted in the north east corner of the activity area.
- Relocation of Object Collections.
- Partial salvage of VAHR 8021-0374
- Salvage report

Sections 1 and 2 provide more information regarding the required management conditions.

7.0 Report on the Desktop Assessment

In accordance with Clause 8, Schedule 2 of the *Aboriginal Heritage Regulations 2018*, this section contains the results of the desktop assessment.

7.1 Aims and Methodology for the Desktop Assessment

The aim of the desktop assessment was to produce an archaeological site prediction model to identify the likelihood of Aboriginal cultural heritage to be located within the activity area. In turn, this assists in the design of fieldwork (survey and/or subsurface testing) and subsequent management conditions.

The desktop assessment involved a review of:

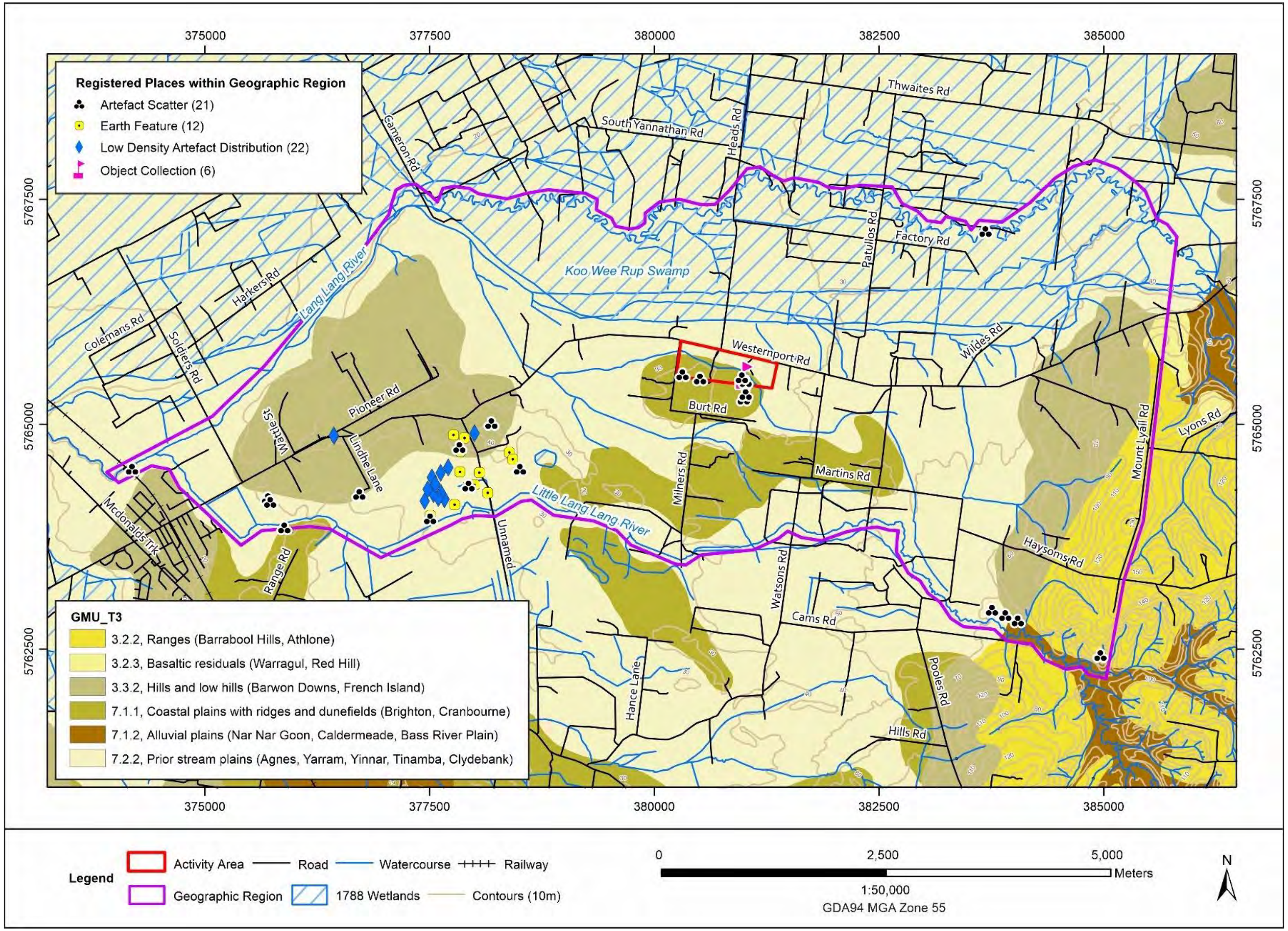
- historical and ethno-historical accounts of Aboriginal occupation of the geographic region and a review of any written and oral local history relevant to activity area;
- environmental resources available to Aboriginal people within the region of the activity area;
- the site registry at the FP-SR and previous archaeological studies to identify any previously registered Aboriginal archaeological sites either within or surrounding the activity area and the results of previous archaeological assessments;
- the land-use history of the activity area, particularly evidence for the extent and nature of past land disturbance; and
- the landforms or geomorphology of the activity area and identification and determination of the geographic region of which the activity area forms a part that is relevant to the Aboriginal cultural heritage that may be present in the activity area.

This information was used to produce an archaeological site prediction model. The site prediction model assists in determining the type of archaeological sites which may potentially occur within the activity area, the possible contents of these sites, the possible past use of the landscape by Aboriginal people and the likely extent of ground disturbance to archaeological sites.

7.2 Results of the Desktop Assessment

7.2.1 The Geographic Region

The geographic region for this project was determined as the land between two rivers, Lang Lang River to the north and Little Lang Lang River to the south. This captures the environmental and geological conditions between the two rivers and allows for an adequate sample of previous archaeological work to form a site prediction model. An arbitrary boundary was identified as Mount Lyall Road to the east (Map 4).



Map 4: Geographic region in relation to the activity area

7.2.2 Landforms and Geomorphology of the Activity Area

Description of Geology, Landforms and Soils

Geology

The activity area comprises two geological units, Alluvium (Qa1): generic and Coastal Dune Deposits (Qdl1): generic (Maps 4 and 5). The alluvium is Pleistocene to Holocene in age and likely formed from channelled stream flow, comprising gravels sands and silts. The coastal dune deposits are Holocene in age and were likely formed by fluctuating sea levels, and adjacent to former lakes and stream beds (Department of Jobs, Precincts and Regions – Agriculture Victoria – Victorian Resources Online 2019).

Geological survey of the activity area describes the subsurface geology as comprising sands deposited in the quaternary and tertiary periods (Maps 6–7). It is likely that these deeper sands represent pre-occupation deposits.

Geomorphological Land Systems

The activity area is located in the present alluvial plain – Gippsland geomorphological unit (Table 2). This unit is a part of the larger riverine plains of south eastern Victoria division. These plains were built up by rivers originating in the East Victorian Uplands which flowed south and deposited alluvium across Gippsland and the Bass Strait. These alluvial deposits formed terraces, plains and the alluvial plain which encompasses the activity area. The higher level terraces are former flood plains which became elevated after uplift in the region. As a part of the lowest geomorphological unit in the system, the flood plains unit of the activity area is characterised by younger, poorly-draining swampy flats formed during the Quaternary. The region is described as extremely flat, dispersed with sandy rises formed along the courses of prior streams (Rowan, Russell & Ransom 2000, p.42).

3rd-tier Geomorphological Units

Victoria's geomorphological framework defines landforms on three tiers at increasingly refined scale. The activity area comprises two 3rd-tier geomorphological units, 7.1.1 and 7.2.2 (Map 4). In the broadest tier, both are Eastern Plains (7) units, low relief level plains with predominantly alluvial Quaternary to recent surface sediments (Department of Jobs, Precincts and Regions – Agriculture Victoria – Victorian Resources Online 2019)..

The southern portion of the activity area is unit 7.1.1. This unit is refined by the second tier of the framework, '7.1 Central Sunklands'. The Western Port Sunkland is a low-lying geomorphic feature defined at its edges by uplifted fault blocks formed by the Tyabb Fault on the west and the Heath Hill Fault on the east. Extensive alluvial deposition into the sunkland only ceased with European modification to drainage systems. The most refined geomorphological description of this unit is tier three '7.1.1 Coastal plains with ridges and dunefields (Brighton, Cranbourne)'. This tier describes the sand formations of the area as stranded dune ridges or former coastlines (Department of Jobs, Precincts and Regions – Agriculture Victoria – Victorian Resources Online 2019).

The northern portion of the property is unit 7.2.2. This unit is refined by the second tier of the framework '7.2 South eastern riverine plains'. The plains are alluvium derived from the Eastern Uplands with only the most recent streams still evident. This more recent framework for classifying geomorphology in Victoria describes the alluvial portion of this activity area differently from the above geomorphological land system classification, classifying it not as present alluvial plain but as a unit higher in elevation, representing former stream plains deposited as natural levees prior to the last Glacial Period "7.2.2 Prior stream plains (Agnes, Yarram, Yinnar, Tinamba, Clydebank)" (Department of Jobs, Precincts and Regions – Agriculture Victoria – Victorian Resources Online 2019).

Landforms and Landform Elements within Activity Area

The activity area is positioned across two landforms, a low, alluvial plain in the north, and a small sandy rise in the south western section. An unnamed modified watercourse runs south east to north west through the activity area.

Soils

The activity area is mapped as containing podosols and texture contrast soils Victorian Soils Map 2014, Agriculture Victoria – Victorian Resources Online 2019).

More generally, the yellow duplex soils with moderate compaction typify the local region (Department of Jobs, Precincts and Regions – Earth Resources GeoVic, 2019). However, there are likely to be two varying types of soils in the activity area, defined by landforms. The alluvial plain portions are likely to be fine sandy clay loams, or light clays, over mottled clays. Buckshot may also be present above clays in these landforms (Sargeant 1975, pp.9–10). In the sandy rises, the better-drained formations have sandy loam or loamy sand soils overlying coffee rock (Sargeant 1975, p.8).

The general definition of a texture contrast soil is that there must be a clear distinction in texture between the A and B horizon and a distinct boundary between the two. Chemical, mineralogical and physical characteristics are not diagnostic. Texture contrast soil texture classes can be very diverse: they can be coarse, with sandy A horizons over silty B horizons, or they can be fine, with clay loam A horizons overlying clay B horizons (Chittleborough 1992, p.815).

The formation processes for a texture contrast soil can be polygenetic with interrelated mechanisms ranging from translocation of clays (facilitated by alternate wetting and drying cycles); accumulation of clays in the B horizon through movement of suspension and deposition of clay plugs in voids (in an environment where there is wetting and drying on a regular basis, such as at the margins of wetlands, then there is more likely to be an interplay between plants absorbing water and clay deposition in the Bt[1] horizon); and bioturbation in soils, causes mineral particles to be moved upwards by soil faunal activity. This can cause an enrichment of the topsoil with coarse-grained material in the surface horizon on top of a heavy-textured subsurface horizon (Chittleborough 1992; see also Phillips 2007, 2004).

The sands mapped at the surface conform to the late Pleistocene Cranbourne Sand geological unit. Cranbourne Sand is a series of siliceous dunes that are described as "Sand, silt, clay: friable to consolidated; well sorted; includes both lunette deposits and deposits of longitudinal dunes" (Department of Jobs, Precincts and Regions – Earth Resources GeoVic 2019). The topsoil typically extends to depths of about 800mm overlaying coffee rock (Map 5; Department of Jobs, Precincts and Regions – Earth Resources GeoVic 2019). Within the activity area, the Cranbourne Sand sits unconformably over the Sandringham Sandstone formation.

Holmes et al (1940, p.188) suggested that the Cranbourne Sand developed on deep quartz sands deposited by fluvial mechanisms from the granodiorite-rich hills to the north, which were subsequently affected by

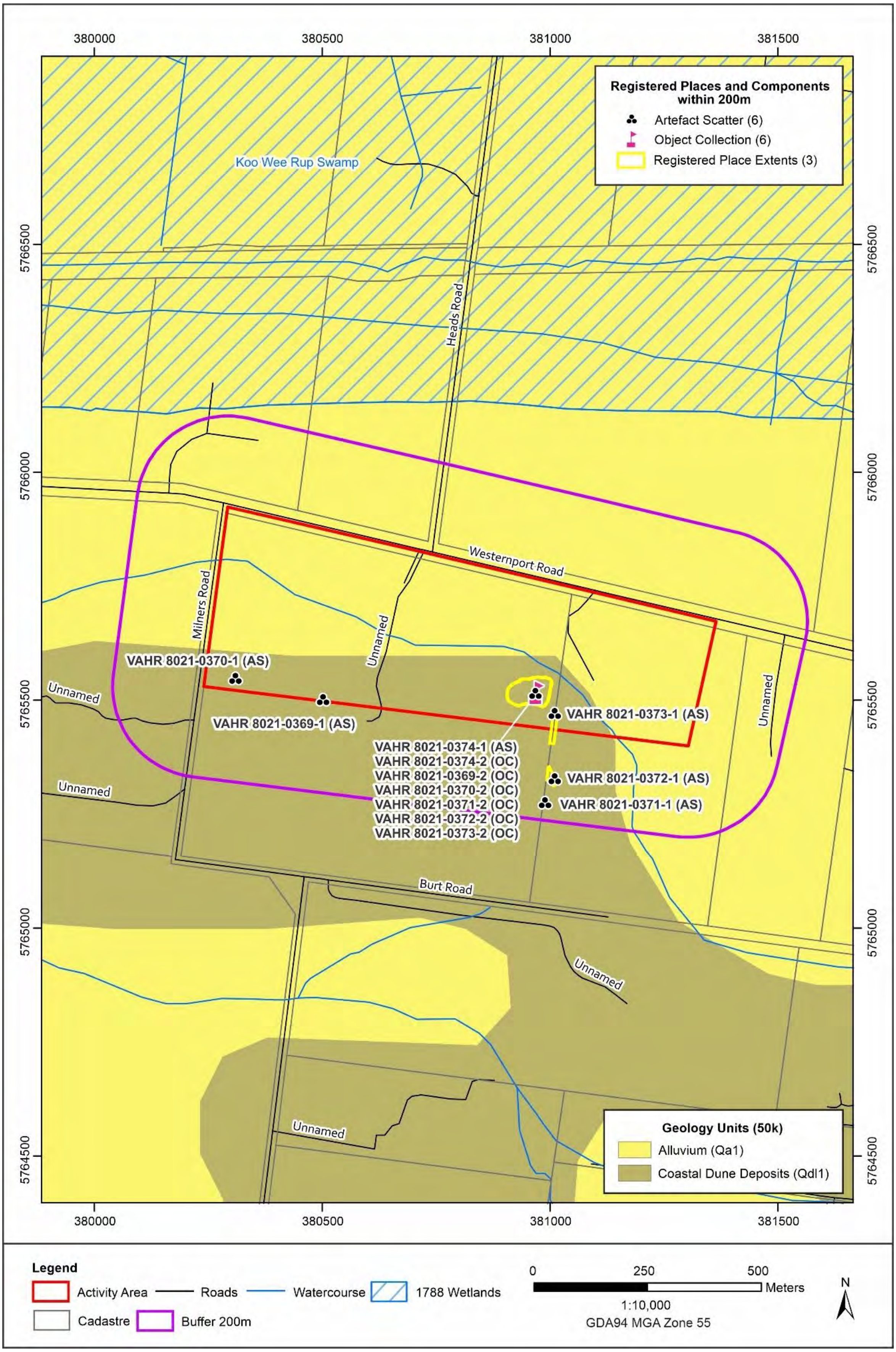
[1] Bt denotes that the horizon is argillic (clay) rich.

aeolian processes. However, this assertion has been subject to revision due to the lack of any evidence suggesting a fluvial or granodiorite origin (Mitchell 2018, p.185). Whincup (1944, p.73) argued that the inland dunes must have formed at a time when protective vegetation was not present so that the surface of the sands was easily affected by wind action. Bowler (2009, p.95) has also suggested that the Cranbourne Sand is the product of "polycyclic dune mobilisation with strong inference of direct association with glacial age events of expanded aridity," that is, there have been multiple dune building events within the last 120 000 years.

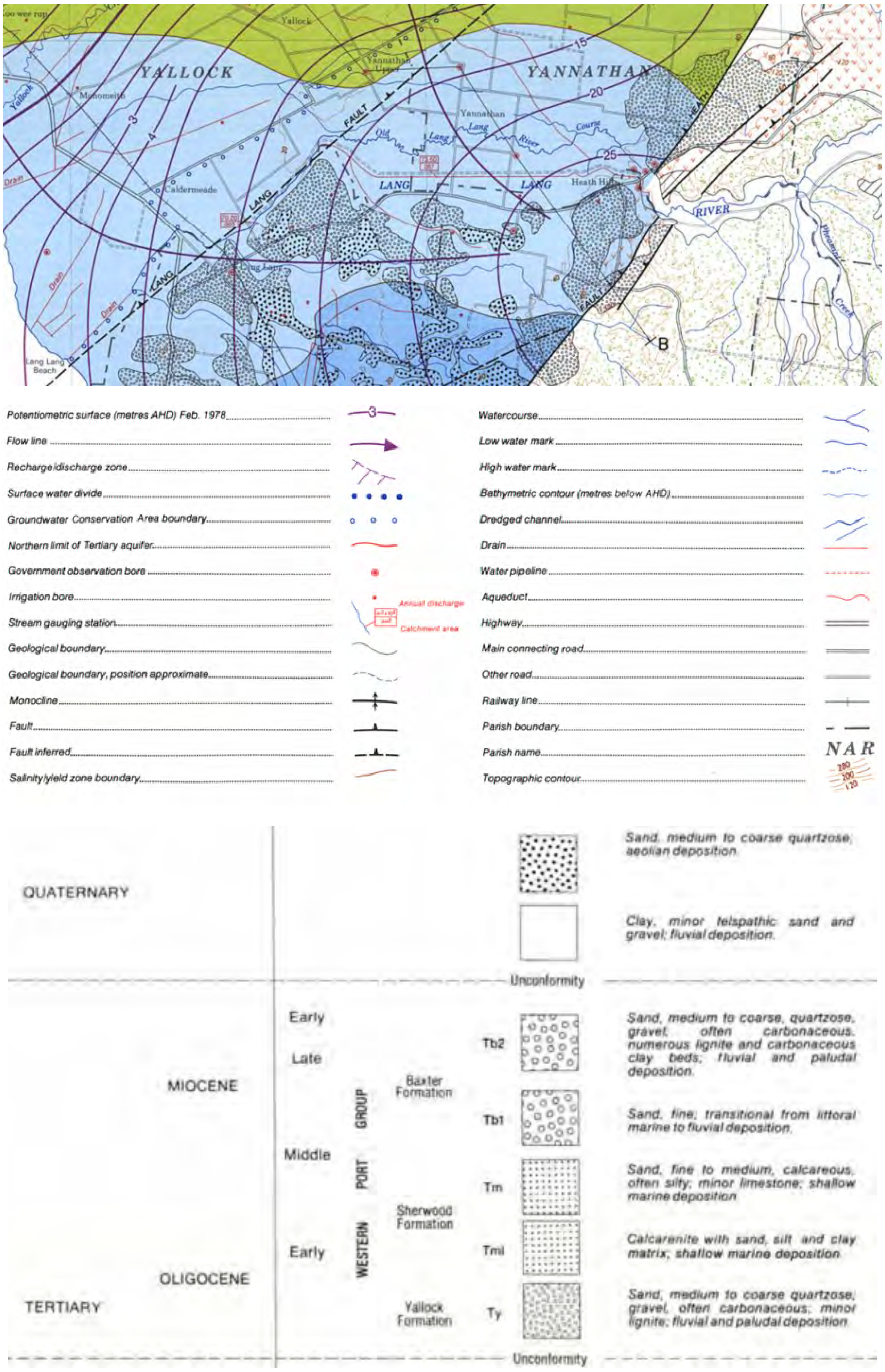
Podosols are likely to be encountered within the activity area, which is indicative of the well-drained, deep quartz sand profiles observed throughout the region. It is diagnostically defined by the presence of a bleached A2 horizon, or E (eluviated) horizon above a B horizon that is dominated by an accumulation of organic material and minerals that have moved out of the upper part of the soil profile (McKenzie et al. 2004, p.296). Due to the nature of sand deposits, particularly in relation to dune field topography and their drainage systems, humic materials tend to accumulate in low-lying areas such as swales, where if the water table is low enough, it becomes concentrated in the B horizon as indurated humate-impregnated sediments forming distinct horizons. It should be noted that the mechanisms under which this occurs is dependent on local conditions and variables in water saturation or drainage (Pye 1982, pp.235–6) and thus susceptible to long-term environmental changes. These indurated horizons, colloquially known as 'coffee rock', but also described as 'hardpan', 'humicrete' or 'sandrock', are common within unconsolidated sand deposits. The formation process is generally considered to be the product of the rapidly decomposed organics (humus), aluminium and iron mineral leached via cycles of dissolution and precipitation from the A horizon into the B horizon where humates and inorganics become concreted (Brooke et al. 2008, p.142). The formation of 'coffee rock' can be of substantial age and predating human occupation of Australia, although concretion processes can be more recent (Allen, Hewitt & De Lange 2008, p.126; Brooke et al., 2008).

Table 1: Summary of land system data encompassing the activity area

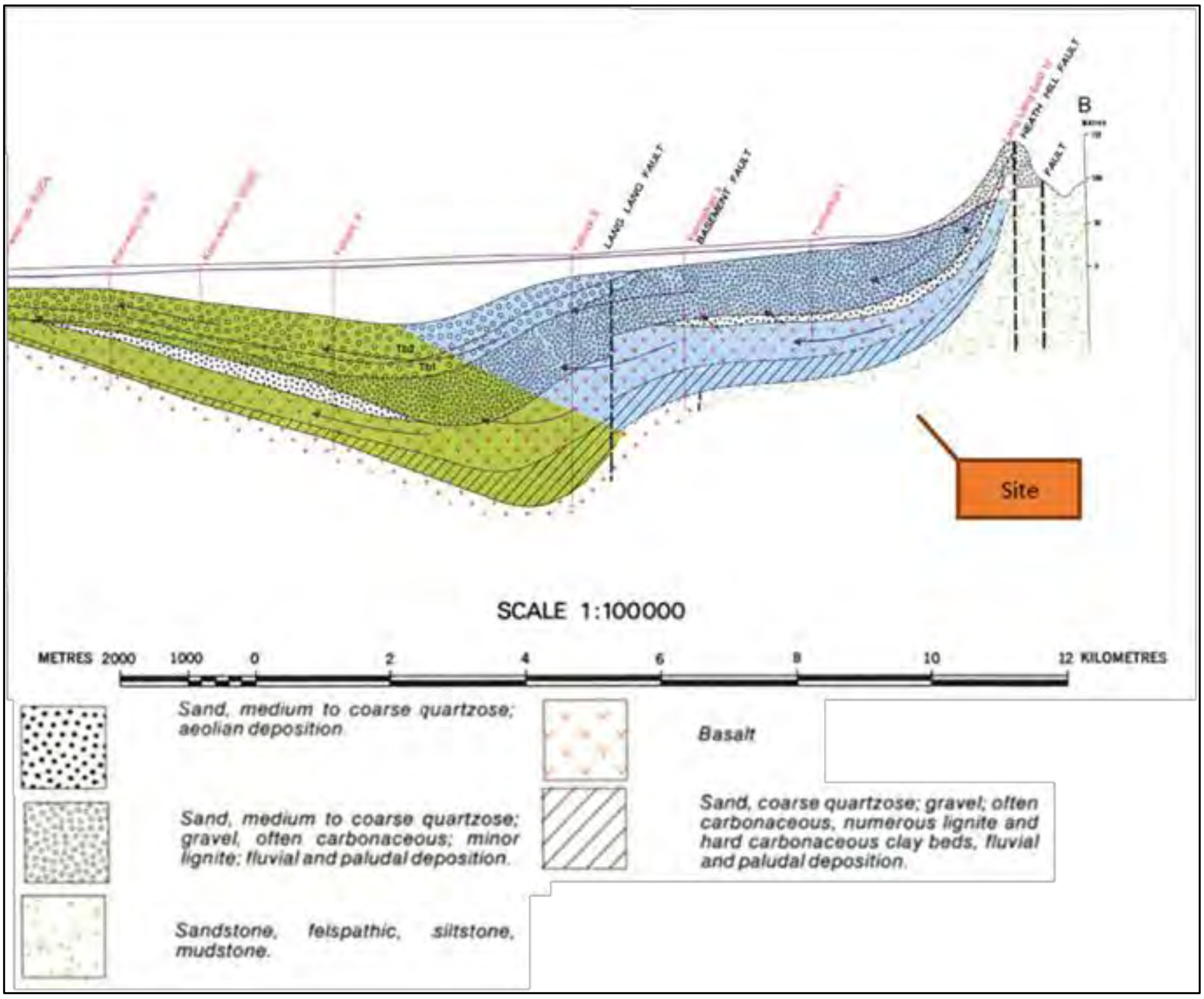
Land System Code – Land Systems of Victoria at 1: 250 000	Land System Summary Description	
9.1FfQ7-3	**Geomorphic Unit:**	Present alluvial plain – Gippsland
	Landform:	Present alluvial plain
	Lithology:	Fine textured unconsolidated deposits silt [material] (significant); sand (significant); gravel [material] (significant)
	Soils:	Yellow duplex soils, moderate compaction, pH <5.5
	Pre-1750 EVCs:	EVC 83, Swampy Riparian Woodland EVC 937, Swampy Woodland EVC 175, Grassy Woodland
	Nearest Water Sources:	Unnamed waterway, Lang Lang River and Little Lang Lang River



Map 5: Geology within the activity area



Map 6: Extracts from 1:100,000 Westernport Hydrogeological Map – regional



Map 7: 100,000 Westernport Hydrogeological Map – cross-section

7.2.3 Resources Available to Aboriginal People Within the Activity Area

Plant Resources and Pre-Contact Vegetation

There are a number of plant species that would have been present across the region in which the activity area is situated which would likely have been utilised by Aboriginal people. The Ecological Vegetation Class (EVC) within the activity area prior to 1750 has been identified as three vegetation types; the north east corner was Swampy Woodland (EVC 937), the south east and the north east corner was Swampy Riparian Woodland (EVC 83) and the west and centre comprised Grassy Woodland (EVC 175; Map 8). However, the current EVC mapping for the activity area shows only agricultural land within the study area (Department of Environment, Land, Water and Planning – NatureKit, 2019).

The native vegetation within the region has been significantly altered and diminished by intensive land use over the past 150 years, and it is not possible to reconstruct a list of all plant resources which would have been used by Aboriginal people and which would have potentially been available within the activity area. The vegetation in the region would also have changed significantly, with fluctuations in climate over the long period of human occupation in Australia. The discussion of Aboriginal plant resources available in the local area is confined to those known to have been used around the time of European occupation in Victoria. The characteristics of the pre-1750 vegetation classes found in the activity area are described below:

EVC 175: the Grassy Woodland EVC appears to be defined by the sandy rise landform within the activity area, which matches its suitability to gentle slopes and undulating hills. The EVC occurs in varying geologies, with more prominent upper stories to 15m in height. Diverse grass and herb components dominate an otherwise sparse shrub component of the lower stories (Department of Environment, Land, Water and Planning – Bioregions and EVC Benchmarks, 2020).

EVC 937: the Swampy Woodland EVC occurs to the north of the unnamed waterway bisecting the activity area. This EVC occurs in swampy, waterlogged heavy soils, such as organic sands or silt and clay-loams which potentially matches the alluvial plain landform component of this property. Dominated by 15m tall eucalypts, particularly swamp paperbark *Melaleuca ericifolia,* this EVC is dominated by tussock grasses, sedges, and herbs (Department of Environment, Land, Water and Planning – Bioregions and EVC Benchmarks, 2020).

EVC 83: the Swampy Riparian Woodland EVC occurs around the unnamed waterway and to the south of the activity area. This EVC is occurs on stream levees and surrounding the low energy streams occurring in foothills and plains, which again matches the alluvial plain components of this property, particularly near the waterway bisecting it. This EVC is dominated not by trees but by shrubs, tussock grasses and sedges (Department of Environment, Land, Water and Planning – Bioregions and EVC Benchmarks, 2020).

Plants were extensively exploited by Aboriginal people for food, medicine and fibres for weaving. Plant components utilised would have included berries, fungi, roots, tubers, bulbs, leaves, pith from fleshy plants, seeds and sap. Gum was also collected from wattle and stored in known locations for seasons when food was less abundant (Zola & Gott 1992). Table 2 below presents a list of known flora and fauna resources collected by Bunurong people.

Table 2: Examples of locally available resources used by *Bunurong* people (Rhodes & Rawoteea 2007; Zola & Gott 1992; Dixon & Blake 1991)

Resource	Scientific or Common Name	*Bunurong* or *Woi wurrung* Name	Uses
Plants	River Red Gum – *Eucalyptus camaldulensis*	*Bial*	Bark used for canoes, shields, shelters (*wilam*) and containers (bark slabs usually cut in spring when sap was running), sap or gum used to treat burns and diarrhoea, leaves used in steam baths for colds and chest infections. Gum used to haft stone tools.
	Common Reed – *Phragmites australis*	*Dirra*	Roots eaten; stems used to manufacture spear shafts (*djirra*) and reed necklaces (*Kourn bert*).
	Water Ribbon – *Triglochin procera*	Not known at present	Tubers cooked in ground ovens and eaten.
	Sedges – *Juncus spp.*	*Dulim*	Stems used to weave baskets.
	Paper Bark – *Melaleuca spp.*	Not known at present	Sheets of paperbark used for wrapping babies (*bulup*); flowers harvested for nectar.
	Tea Tree – *Leptospermum spp.*	Not known at present	Bark for nets; wood used for spears.
	Marsh Club-Rush – *Bolboschoenus medianus*	*Burt burt*	Roots (tubers) pounded and baked.
	Water lilies – various	Not known at present	Roots eaten.
	Reeds – *Juncus spp.*	Not known at present	Stems of reed cut into strips and used for manufacture of baskets.
	Tussock Grass – *Poa spp.*	*Bowat*	Leaves and stem used for string fibre – used to manufacture fishing nets, bags, baskets and mats.
	Spiny-headed Mat-Rush – *Lomandra longifolia*	*Karawun*	Used for manufacture of baskets.
	Bracken Fern – *Pteridium esculentum*	*Buyet*	Roots roasted and beaten into paste for eating; leaves used as insect repellent.
	Yam Daisy – *Microseris lanceolata*	*Murnong*	Tubers eaten raw or roasted; syrup (*minne*) produced when roasted was also eaten. This was a staple plant food of Aboriginal people throughout many parts of Victoria.

Resource	Scientific or Common Name	*Bunurong* or *Woi wurrung* Name	Uses
	Native Raspberry – *Rubus parvifolius*	*Eepaeep*	Consumed as food.
	Kangaroo Grass – *Themeda australis/triandra*	*Buath/banum/wuuloitch*	Leaves and stem used for string fibre (*wugel-wugel*) – used to manufacture fishing nets (*garrt-kirrk*), bags, baskets and mats.
	Kangaroo Apple – *Solanum laciniatum*	Not known at present	Ripe fruit eaten.
Fish	Eel – particularly Short-finned Eel, *Anguilla australis*	*Yuk*	Speared, caught with feet and probably netted. Eels were an important resource found in Carrum Swamp. William Thomas recorded large gatherings of *Bun wurrung* people at Carrum Swamp in March 1841 (Gaughwin & Sullivan 1984).
Reptiles	Common Long-necked Tortoise – *Chelodina longicollis*	Not known at present	
	Tiger Snake – *Notechis scutatus*	Possibly *dharrandel*	
	Eastern Brown Snake – *Pseudonia textilis*	*Gulunung*	Flesh roasted and eaten; venom known as *bonnongi.*
Mammals	Short-beaked Echidna – *Tachyglossus aculeatus*	*Gawa(r)n*	Meat eaten; quills used in decorative necklaces.
	Eastern Grey Kangaroo – *Macropus giganteus*	*Tooremut*. *Kororoit* = male kangaroo	Hunted with spears; meat roasted and eaten; skins used for clothing and shelters; claws used as spear barbs; bone for awls and needles; and sinew for binding.
	Common Brushtail Possum – *Trichosurus vulpecula*	*Walert*	Hunted, usually smoked out of trees; meat roasted and eaten; skin used for clothing, particularly cloaks.
	Swamp Wallaby – *Wallabia bicolor*	*Wimbi*	
	Common Ringtail Possum – *Pseudocheirus peregrinus*	*Bamun*	Hunted, usually smoked out of trees; meat roasted and eaten.

Fauna Resources

A number of animals would have been present within the activity area and are likely to have been hunted by Aboriginal people. These include a range of mammal species including possums, antechinus, bandicoots, bats, kangaroos, wallabies, echidnas, koalas and native rats. A large range of birds (dominated by waterbirds) would have been present and utilised for food (meat and eggs) and feathers. Reptiles in the region would have mostly comprised small skink species, but also several snakes and blue-tongue lizards (Atlas of Living Australia n.d.).

As well being a valuable food source, kangaroos and possums provided raw materials for the manufacture of cloaks, while kangaroo teeth were worn (as were bones and shells) as hair decorations and echidnas provided quills which were used to make necklaces (Sullivan 1981, p.23; Rhodes & Rawoteea 2007, p.18).

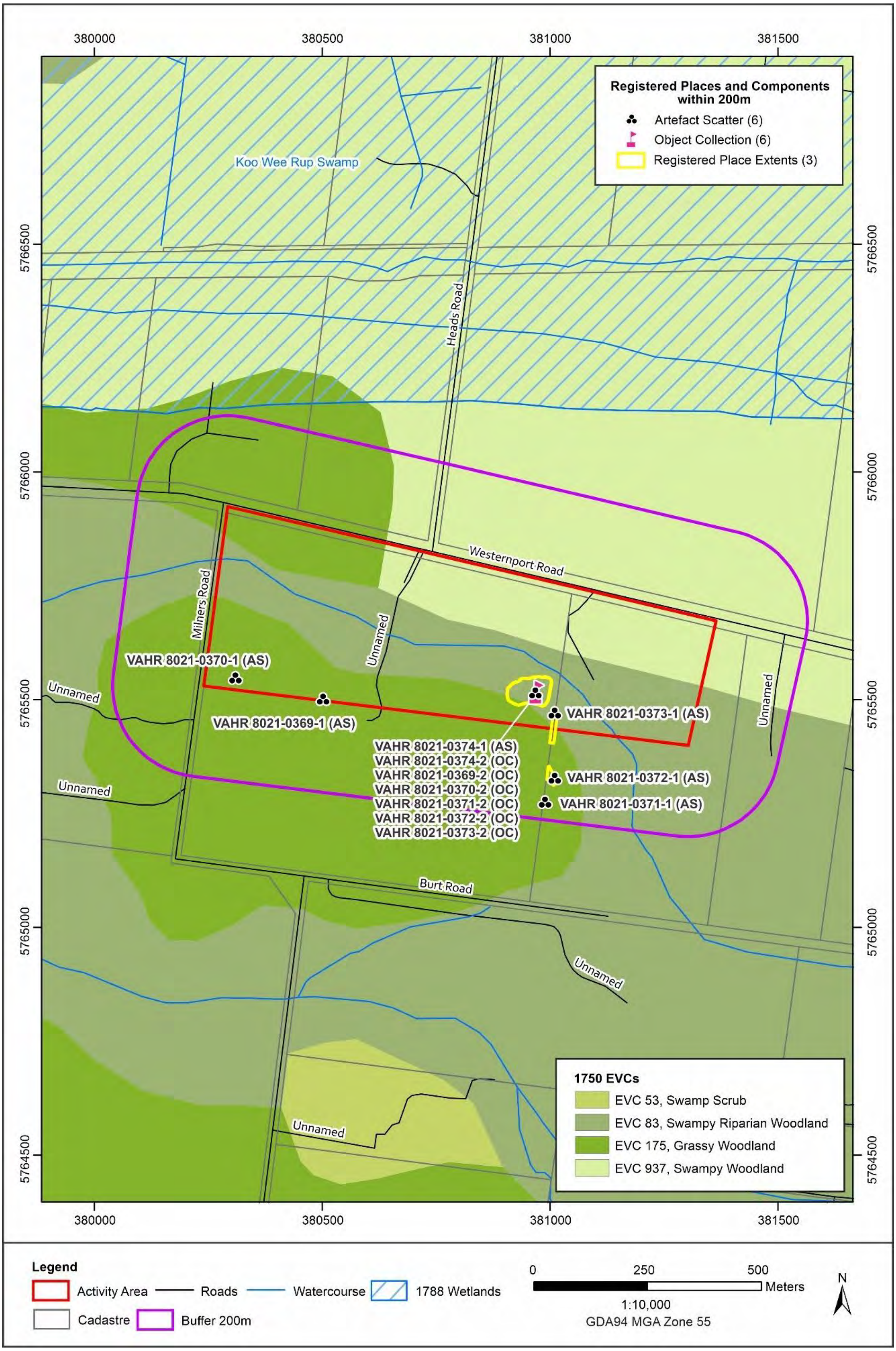
The native fauna in the geographic region is significantly diminished in modern times, largely as a result of the loss of habitat, with many animal species once present now locally or regionally extinct.

Water Resources

The closest fresh water source is an unnamed waterway running through the property, as well as both Lang Lang River and Little Lang Lang River. Additionally, the southern edge of the former Koo Wee Rup Swamp is only 260m to the north of the activity area (Department of Environment, Land, Water and Planning – NatureKit 2019). The swamp would have been resource rich and an attractive locale for hunting and foraging, whilst the creeks and rivers would have provided fresh drinking water. Locations within a short distance to fresh water were ideal places to camp, hunt and travel. The unnamed waterway running through the activity area was likely ephemeral and may have been running after seasonal heavy rainfall. It has also been recently modified along its eastern section. This would have supported a variety of plants and animals and recharged swampy depressions on the alluvial plain landforms. Increased water availability during late autumn, winter and early spring would have made it an optimal time for access to drinking water. The waterlogged ground during these periods may have made sandy rises in the area desirable as dry refuges for camping and hunting.

Stone Resources

The more recent alluvial and aeolian geology of the activity area, lacking in any exposed bedrock, or stony geology, precludes it from containing any raw material sources from which stone tools could be produced. Thus, any stone tools produced, used or discarded within the area must have been imported from sources elsewhere. Potential raw material sources nearby include the Newer Volcanics to the east which often produce silcrete outcrops and granites to the north and west which can produce contact metamorphic stone like hornfels, as well as quartz (Ellender 1991, p.10).



Map 8: Pre-1750 EVC within the activity area

7.2.4 Search of the Victorian Aboriginal Heritage Register

The Victorian Aboriginal Heritage Register (VAHR), accessed through Aboriginal Cultural Heritage Register and Information System (ACHRIS), was searched to identify any previously registered Aboriginal Places within the geographic region for the activity area, as well as the results of previous archaeological assessments. The Register was originally accessed on August 6, 2020 by Thomas Fallon. An updated search of the VAHR was undertaken on January 19, 2022 by Grace McKenzie-McHarg, and second updated search of the VAHR was undertaken on September 8, 2022 by Zoe Lay.

7.2.4.1 Aboriginal Places in the Geographic Region

At the time of the September 2022 search of the VAHR a total of 21 registered Aboriginal Places were present within the geographic region, comprising a total of 61 components (Table 3). Aboriginal Places within the geographic region, are comprised of artefact scatters, LDADs, earth features and object collections. The artefacts occur in varying densities from isolated stone artefacts to scatters of up to several hundred pieces and the earth features are noted to be hearths. Both of the latter component types predominantly occur either within sandy rises or along waterways.

Table 3: Summary of registered Aboriginal Places within the geographic region

Component Type	Frequency (No.)	Frequency (%)
Artefact Scatter	21	34
LDAD	22	36
Earth Feature	12	20
Object Collection	6	10
Total Components	**61**	
Total Registered Places	**21**	

Sites within 200m (Map 9; Table 4) are all artefact scatter site types (n=16), apart from object collections (n=6). These occur in densities of one to 12 pieces and are all located in sandy rise landforms in an otherwise flat alluvial plain environment.

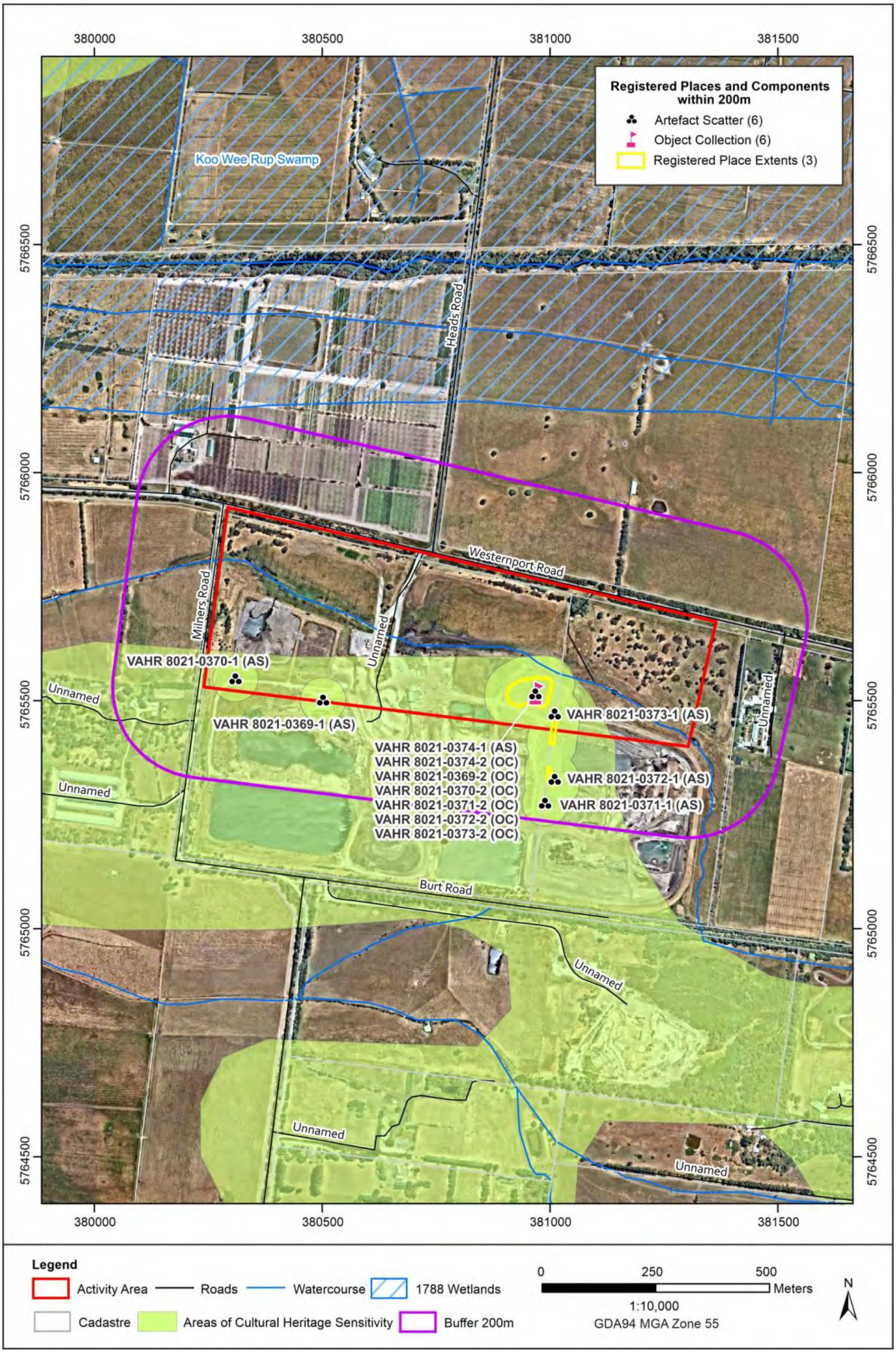
Of the previously registered sites, VAHR 8021-0369, 8021-0370, 8021-0373, and 8021-0374 exist within the current activity area (also listed in Table 4 – see comments). VAHR 8021-0369 is comprised of a single isolated silcrete flake found on the surface; VAHR 8021-0370 is comprised of a single silcrete artefact found on a sandy rise in sub-surface context; VAHR 8021-0373 is comprised of 11 artefacts (raw materials include silcrete and quartz) found on a sandy rise in sub-surface context; VAHR 8021-0374 is comprised of 12 artefacts (raw materials include silcrete, chert and quartz) found on a sandy rise in sub-surface context.

Table 4: Previously recorded Aboriginal Places within 200m of the activity area

VAHR No.	Site Contents	Site Density	Depth of Artefacts	Landform	Comments
8021-0369	Isolated artefact – silcrete	Isolated	Surface	Sandy rise	This registered site exists within current activity area
8021-0370	Isolated artefact – silcrete	Isolated	30–40cm	Sandy rise	This registered site exists within current activity area

VAHR No.	Site Contents	Site Density	Depth of Artefacts	Landform	Comments
8021-0371	1 silcrete, 1 quartzite artefact	Low	80–100cm	Sandy rise	
8021-0372	12 silcrete and quartz artefacts	Low	10–110cm	Sandy rise	
8021-0373	11 silcrete and quartz	Low	50–60cm	Sandy rise	This registered site exists within current activity area
8021-0374	12 silcrete, quartz, quartzite and chert artefacts	Low	40–50cm	Sandy rise	This registered site exists within current activity area

There were no Aboriginal historic references within the geographic region



Map 9: Aboriginal Places within 200m of the activity area

7.2.4.2 Previous Work in the Geographic Region

A limited number of reports have been undertaken within the geographic region. The results of relevant regional and localised studies are presented below and in Table 5. This review of relevant reports within the geographic region has been undertaken to assist with the formulation of the site prediction model. As there have been limited numbers of reports undertaken in the geographic region, the majority have been reviewed here save where there were multiple reports produced for one activity area and/or little information was to be gathered from them.

The review of previous archaeological research has shown that the majority of nearby studies have been on rural lots which have been used for agricultural purposes, particularly grazing. The surface surveys tended to be limited by poor ground visibility, while the excavation revealed that the majority of Aboriginal cultural heritage material was stone tools in varying densities located in primarily subsurface contexts, almost always in sandy rise landforms. Eight of the 11 reports reviewed either had previously recorded Aboriginal Places or identified some during the assessment in some capacity. Stone artefacts were recorded in almost every instance where subsurface testing or salvage was undertaken on a sandy rise. Disturbance to the upmost topsoil layer was generally due to native vegetation removal and agricultural causes such as ploughing and stock trampling.

<u>Previous Investigations in Close Proximity to the Activity Area</u>

Proposed Sand Quarry Extension, Yannathan, Westernport Road, Lang Lang East, Victoria: Desktop, Standard and Complex Assessments, Cultural Heritage Management Plan, 2012

CHMP 11342 (Barker & McAlister 2012) is an approved plan which overlaps the current activity area and was completed to the level of a complex assessment. The desktop assessment found that the landforms on the property were swampland bordered by low sandy rises. Although at the time no Aboriginal Places had been identified within the immediate vicinity of the activity area, the report recognised the potential for scarred trees and isolated artefact scatters to occur in sandy rises within flood plain environments. The location was likely to be resource rich, however given the distance from a fresh water source, Lang Lang River, the report concluded that it was unlikely to have been used as a large or long-term campsite. The report noted that the archaeological record suggested campsites and occupation areas usually occur less than 1km from fresh water. The activity area is 2.5km from Lang Lang River and was therefore likely to have been a short term camping site associated with hunting or foraging expeditions. Barker and McAlister (2012) conclude that flat flood plain landforms within the activity area were unlikely to contain Aboriginal Places, whereas sandy rises which sit above the flood plain were more likely to contain small scatters or isolated culturally modified stone artefacts.

The standard assessment was undertaken in order to assess for potentially sensitive sandy rise landforms, and to locate any surface cultural heritage material. No Aboriginal cultural heritage material was located during the survey. The assessment noted that disturbance had been incurred during past clearing of native vegetation, stock grazing and the excavation of the existing sand quarry, and construction of its associated buildings and service. The survey confirmed the activity area largely comprised low-lying swampy flood plain landforms with a low sandy rise, which was assessed as potentially sensitive for Aboriginal cultural heritage material. As there was very poor ground surface visibility and a potential for sub surface artefacts, it was necessary to undertake complex assessment.

The complex assessment comprised the excavation of eight 1x1m test pits, 50 500x500mm shovel test pits, and 26 2x1m mechanical test pits. Six Aboriginal Places were recorded within the activity area on sandy rises overlooking the flood plain (VAHR 8021-0369 to VAHR 8021-0374). As predicted during the desktop assessment, no Aboriginal cultural heritage material was identified within the flood plain landform itself. The soil stratigraphy in the sandy rise landform was generally sandy loam topsoils in the upper portions of the pits, with the bulk of the sediment consisting of sand over coffee rock. Soil stratigraphy in the low-lying flood plain consisted of dense, waterlogged silty clay sand, revealing the water table and confirming the low-lying swampy nature of the landform. Basal deposits in these areas comprised mottled grey and yellow-orange clays at an average depth of 350mm. Artefacts were located at various depths within the sensitive sandy rises but generally at the base of the sandy layers, just above the coffee rock. Coffee rock was observed at variable depths throughout the activity area, occurring between 400mm and 1100mm.

Three of the Places (VAHR 8021-0369 to VAHR 8021-0371) identified within the activity area were registered as isolated artefacts. They comprised one silcrete angular fragment, one silcrete flake and a silcrete complete flake and quartzite complete flake, respectively. The remaining three Aboriginal Places were artefact scatter registrations (VAHR 8021-0372 to VAHR 8021-0374), comprising 12, 11, and 12 artefacts respectively. The artefacts were mostly silcrete, with minor numbers of milky quartz, quartzite and chert artefacts, and the majority are flakes or angular fragments, with only two cores.

All of the Places identified in this study were located within the sandy rise landform around the quarry site and were located in sandy deposits above the basal coffee rock layer. Since 2012, further excavation in the region has revealed that coffee rock is not always an indicator of sterile deposits and can cap important cultural deposits (e.g., (Barker & Williamson 2020, p.36). The results of the standard and complex assessment largely conformed with the predictions of the desktop assessment. It was noted that the test pits were excavated at the fringes of what was probably a larger site on the sandy rise, but which has been previously quarried and therefore destroyed. The stone artefact assemblage reflects maintenance and reuse of stone tools, as well as some production of stone tools as reflected by the presence of two cores.

The CHMP did not recommend the protection of any Places except VAHR 8021-0374. No salvage was required of any of the Places. Custodianship and reburial was recommended and carried out for artefacts located during the study. The object collections (8021-0374-1 (OC); 8021-0374-2 (OC); 8021-0369-2 (OC); 8021-0370-2 (OC); 8021-0371-2 (OC); 8021-0372-2 (OC); 8021-0373-2 (OC), were subsequently reburied within the extent of VAHR 8021-0374. A cultural heritage induction was also recommended and carried out.

Relevant Local and Regional Studies

Report 193 (Gaughwin & Sullivan 1984) is a regional report for the Western Port area which is of interest to the activity area. During this extensive study, Gaughwin recorded a total of 266 Aboriginal archaeological sites, only one of which was located within the area that Gaughwin describes as 'Inland Plains', which includes the present activity area landform. The most common site type recorded during her study was middens, with surface scatters of stone tools the next most common. The closest region to the present activity area that showed a high site and artefact density was found to occur on sandy ridges in the Cranbourne area, particularly those associated with water. This landform model has direct correlation with the Lang Lang activity area. Gaughwin determined that the sites located within these sand ridges are situated to take advantage of resources associated with swamp depressions. Due to the poor surface visibility within the 'Inland Plains' area, it was thought that many more sites than those recorded by the site survey could occur. Furthermore, due to the degree of disturbance to the landscape within much of this area, it was be expected that most of these sites will be disturbed to some extent.

Table 5: Previous studies relevant to the activity area

Study Name	Distance From Activity Area	Results
Proposed Sand Mine, Lang Lang: Cultural Heritage Assessment (Murphy 2001) Rep: 1966	450m south	This report (1966) was undertaken for the proposed sand extraction mine and included an Aboriginal cultural heritage study and foot survey. The landforms and soils within the study area are not thoroughly detailed but a sandy rise on the property is mentioned. The region is defined by two geologic unit: windblown sand deposits which form sandy rises in the landscape and swamp deposits comprising sand, silt, clay and gravel. There were no existing Aboriginal Places within the study area, and none were located during survey. It was also considered unlikely that any would be located within the sandy rise(s), however it was recommended that remnant native vegetation be preserved.
Proposed Subdivision: Lot 435 Range Road, Lang Lang (Murphy 2007)	4000m south west	This report (4032) was undertaken for a proposed subdivision and included an Aboriginal cultural heritage study and foot survey. Landforms within the study area were two small rises in otherwise flat land with recent disturbance in the form of channels and irrigation. The soils in the rises were sandy loams and the flat areas were peaty sandy loam. Within the study area, the geology comprised two geologic units: the flat areas were sedimentary soils which may have been swamp or river deposits and the rises are likely to be windblown sand deposits. The study area was stoneless and as such, any stone tools found must have been imported from other places, potentially the nearby 'Haunted Hills Gravels'. The location of the study area between swamp, creek, and dry land meant that it was potentially resource rich prior to European settlement. There was one previously recorded Aboriginal Place (VAHR 8021-0136) within the study area. The Place was located during an earlier study, a summary of which will be provided below (see Murphy (2007) noted that Aboriginal Places around Lang Lang reflect a preference for elevated dry land, usually within the Cranbourne Sand landform, and comprise both surface and subsurface artefacts made from silcrete and quartzite. During the foot survey, effective survey coverage was low due to low ground surface visibility. No new Aboriginal Places were identified, but it was recommended that further subsurface testing be undertaken to mitigate a lack of ground surface visibility in the more sensitive sandy rises.

Study Name	Distance From Activity Area	Results
Lot 435 Mcdonalds Track Lang Lang – Extractive Works (Murphy & Deftereos 2009)	4000m south west	This CHMP (10557) was undertaken for proposed extractive works at the same location as Murphy 2007and was completed to the level of complex assessment. The desktop noted similar results as both the background study and foot survey from Murphy 2007. The complex assessment phase of the study comprised 10 1x1m test pits and 101 500x500mm shovel probes. Stone artefacts were located in seven of the test pits and 15 of the shovel probes, resulting in the expansion of the VAHR 8021-0136 artefact scatter and the registration of a new artefact scatter (VAHR 8021-0273). A total of 59 artefacts were recovered from within the activity area, comprising primarily silcrete with some quartzite, flint, quartz and 'fine grained siliceous'. The artefacts were flakes and angular fragments as a majority, with few cores and tools. Artefacts were located in sandy silt loams from 0–700mm, which overlay 'ferricrete' and clay contexts. A salvage program was recommended for VAHR 8021-0273 and is detailed below (Murphy 2015).
Lot 435 Range Road, Lang Lang VAHR 8021-0273 Salvage Excavation (Murphy 2015)	4000m south west	This report (4683) details the salvage of VAHR 8021-0273 as recommended in CHMP 10557. Salvage comprised a single 2x2m test pit which recovered a single artefact at 300–350mm in clayey sand fill. The stratigraphy of the test pit was highly disturbed and exhibited no natural soil horizons. The top 0–550mm was clayey sand fill, over clay fill and natural clay. The final total of artefacts at this Aboriginal Place came to 14. Murphy (2015) suggested that, given the low density of artefacts, this location was likely to have been used as a point at which to stop and repair a tool kit or process game, but would have been used irregularly and would not have been a focus for exploitation or occupation.
Desalination Project, Northerly Grid Connection and Ancillary Power Infrastructure Component: Discontinued (Orr 2008)	2415m east	This discontinued draft CHMP (10619) was undertaken for the linear ancillary power infrastructure component of a larger desalination project. It was partially completed to a desktop level with aerial reconnaissance before it was discontinued. No mapping was undertaken which prevents useful examination of desktop or aerial results for this project.

Study Name	Distance From Activity Area	Results
Lang Lang Truck Bypass, Westernport Road To Range Road (Murphy & Morris 2011)	4675m south west	This CHMP (11221) was undertaken for a proposed truck bypass around Lang Lang township and was completed to the level of complex assessment. The desktop assessment found that there had been two prior surveys undertaken in the activity area, one of which (Murphy 2007) identified an artefact scatter just outside the activity area (VAHR 8021-0136 artefact scatter; two quartzite flakes and one crystal quartz flake in quarried sand deposit). There were no previously recorded Aboriginal Places within the activity area. Due to prior surveys being conducted no standard assessment was undertaken and the project progressed directly to complex assessment. During complex assessment three Aboriginal Places were identified (artefact scatters VAHR 8021-0358, VAHR 8021-0359 & VAHR 8021-0360) in silty sands at depths between 250 and 650mm in elevated sand dunes, likely formed in the Holocene. The complex assessment identified a total of 15 silcrete artefacts with some quartzite and quartz all primarily flakes and angular fragments. There were no cores or retouched flakes.
Little Lang Lang River Maintenance – Milners Road To Pooles Road – Lang Lang East (Kennedy 2012)	1520m south	This CHMP (11842) was undertaken for proposed river maintenance works along little Lang Lang River and was completed to the level of complex assessment. The geologies identified within the activity area were alluvium, dune deposits and swamp and lake deposits, and the study recognised the potential sensitivity of any elevated landforms adjacent to the waterway. During the standard assessment there was an overall effective survey of 20% due to varying ground surface visibility. The complex assessment noted agricultural disturbance along the majority of the waterway with predominantly silty and clay loam alluvial soil profiles above heavy clay. No Aboriginal Places were identified within the activity area during this assessment.
Little Lang Lang River Realignment, 435 Mcdonalds Track, Lang Lang (Murphy & Morris 2012)	3630m south west	This CHMP (12165) was undertaken for the realignment of the Little Lang Lang River and was completed to the level of complex assessment. The desktop assessment identified that one Aboriginal Place (VAHR 8021-0136) had been previously registered within the activity area. The standard assessment identified no new Aboriginal Places but located sandy rises on the property which were potentially sensitive and which would require further investigation during complex assessment. The complex assessment comprised two 1x1m and 24 500x500mm test pits across sandy rise and clayey flood plain landforms. One new Aboriginal Place (VAHR 8021-0375) was recorded as an artefact scatter comprising 29 silcrete artefacts within sand and sandy silt contexts at depths of 150–350mm. The report concluded that due to the presence of cores and small artefacts, it was probable that people were knapping at the later stages of core reduction and that the Place represented transitory occupation and low frequency visitation due to the low density of stone artefacts.

Study Name	Distance From Activity Area	Results
Residential Subdivision, 11 Thom Road, Lang Lang, Victoria (Burch & Evans 2019)	5845m south west	This CHMP (15815) was undertaken for a proposed subdivision and was completed to a complex level of assessment. The desktop and standard assessments did not locate any Aboriginal cultural heritage material, but did identify two landforms with high archaeological potential: land adjacent to the Lang Lang River and a low rise on the boundary of the property. The complex assessment comprised eight 1x1m test pits and 12 shovel test pits. Two Aboriginal Places were registered as a result of the assessment (VAHR 8021-0437 and VAHR 8021-0438). VAHR 8021-0437 is an artefact scatter with 22 pieces of ochre and 244 flaked stone artefacts in silt and clayey silt at depths between 0–600mm, potentially representing intensive occupation of the alluvial terrace and bank of the former unchanneled course of the Lang Lang River. The presence of flaked glass in the assemblage may indicate that it is a site from the Contact period. VAHR 8021-0438 comprises an artefact scatter of 12 flaked stone pieces located at depths of between 0–600mm in sandy silt on a low rise 220m from the Lang Lang River.

7.2.5 Historical and Ethno-Historical Accounts in the Geographic Region

Prior to European occupation, the central portion of what is now the state of Victoria was occupied by Aboriginal people who shared a common language and political, social, religious and economic affiliations and who identified themselves as *Kulin*, the label meaning 'man' in the dialect spoken in the Melbourne region (Blake 1991, p.31). The area of land occupied by the *Kulin* people extended as far north as present day Echuca, west as the Richardson River, Mount Avoca, Fiery Creek and Mount Emu Creek, south to the Victorian coastline and east to the Tarwin River and Wilsons Promontory (Blake 1991, p.30; Clark 1990).

Within the *Kulin*, a number of different but related dialects or *wurrung* (= lips, speech, mouth) were spoken. Generally speaking, different dialect groups among the *Kulin* were delineated by association with a specific area of country. These dialect groups, named the *Woiworung, Bunurong, Taungurong, Nguraiwurung*, *Wadawurrung* and *Dja dja wurrung*, comprised a 'regional cultural confederacy known as the Kulin' (Barwick 1984, pp.104–105). The activity area lies within land which was occupied by clans speaking the *Bunurong* dialect of the *Kulin* language.

Among the *Kulin*, political, social and economic relationships were shaped by affiliation with the main unit of social organisation (the clan) and affiliation with one of two groups linked with creation ancestors. A clan was usually formed from a number of related families (a lineal descent group) which claimed guardianship over a particular tract of land (Howitt 1904, p.41; Cotter 2001). *Kulin* clans supposedly traced descent through the male line (patrilineal descent; (Clark 1990, p.363), although this is disputed by some contemporary descendants of the BLCAC.

The *Kulin* were also divided into two groups (described as moieties by western anthropologists) linked with creation ancestors. These groups were *Waa* (Australian Raven) and *Bunjil* (the eaglehawk; (Barwick 1984, p.105). Affiliation of an individual with either *Waa* or *Bunjil* was determined at birth by the group/moiety affiliation of the father and the father's clan (Barwick 1984, p.105; Clark 1990).

In traditional *Kulin* law, moiety and clan affiliation determined marriage. Individuals were required to marry outside their clan and to a person belonging to the opposite moiety. Thus, an individual who belonged to the *Waa* descent group could only marry a person from another clan and from the *Bunjil* descent group. Marriages were often arranged at large ceremonies involving clans from a number of different geographical locations.

Marriage had an extremely important influence on social and economic relationships, and individuals could acquire considerable status and economic power through marriage ties, particularly men who could afford to support more than one wife. Access to the land and resources of another clan was most often gained by a kin relationship formed by marriage (Barwick 1984, p.106), although geographical proximity of birth or descent could also form grounds for access. Marriage also imposed a mutual obligation of each clan to provide access to some or all of the resources of another, so that reciprocal sharing of resources was fundamental to land management (Barwick 1984, p.106).

William Thomas, Assistant Protector of Aborigines in the Western Port district from 1839, spent much of his time travelling with *Bunurong* people between his hut at Arthur's Seat, the Aboriginal reserve (which he established at Narre Narre Warren during 1841), and the Aboriginal camps around Melbourne (Sullivan 1981, p.25; Cannon 1983). According to Thomas, the *Bunurong* claimed 'all the country south of the Yarra River, whose creeks and inlets falls into the sea from the Werribee River west to the Tarwin River, east of Cape Patterson' (Thomas papers, Vol. 7, 17/1/1860, cited in Clark 1990).

Gunson (1974, p.10) stated that members of the *Bunurong* usually camped beside waterholes, creeks and at coastal locations. Early settlers of the Western Port region also noted that Aboriginal campsites containing huts were often found beside rivers and creeks (Sullivan 1981, p.33). There are no burial sites recorded within a 5km radius of the activity area; however, Thomas saw a burial location beyond Torbinerk (Lang Lang) in 1840 (Gunson 1974, p.10). Recorded burials within traditional *Bunurong/Boon wurrung* land include the fore-dunes at San Remo, Mornington Peninsula and Venus Bay. However, there is historical evidence that burial sites within the Western Port region were both common and conspicuous. Members of the *Kulin* were known to both bury their dead and place them in tree hollows that were often subsequently burnt. Thomas noted that:

> Wood was pulled up to a height of 3 feet and the ground burnt all around, this was of long standing as the woods were literally decayed and dirt over them, I suppose there were 50 sticks laid horizontal thus. At the end was a large dead trunk and hollow burnt in it as if not done by chance. I examined it but could not trace anything worthy of remark further than it appeared to have been many years previous (Gunson 1974, p.10).

During 1839, the British Colonial Government established an Aboriginal Protectorate in what is now Victoria. A Chief Protector, GA Robinson, and four Assistant Protectors were appointed to administer the Protectorate. William Thomas was appointed Assistant Protector for the Port Phillip and Western Port Districts and had extensive contact with traditional *Bunurong* people during the early years of European settlement (Cotter 2001, pp.1–2). Thomas travelled with groups of *Bunurong* and related *Woi wurrung* people on seasonal movements around the Mornington Peninsula and Western Port, producing a map in 1841 showing the locations of *Bunurong* campsites and routes of movement.

Historical references to movement of *Bunurong* people through the Mornington Peninsula and Western Port areas note that there appear to have been multiple major routes of movement across *Bunurong* country; the western route runs from Dandenong, along the margins of swampland and near Hall Road. It intersected with a second pathway to the east, which ran close to the alignment of the present-day South Gippsland Highway. Both of these pathways met at Cranbourne. The second path followed the higher dunes and sand ridges but still passed close to swampy terrain. Other routes of movement follow along the coastline, following present day Beach Road and Nepean Highway, while another route is mapped running around the coast of Western Port Bay which may have connected the activity area to travel routes and the eastern side of Koo Wee Rup Swamp (Rhodes & Rawoteea 2007).

Figure 1 Overlay of Bunurong campsites, places and pathways, c.1835–1841 on Landsat Image (after Rhodes & Compton 2005)

Thomas recorded most of the limited documented information regarding the lifestyle of the *Bunurong* people occupying the littoral between Port Phillip Bay and Western Port Bay, however, other settlers and travellers such as Daniel Bunce (1856) and George Haydon (1846) have contributed to a broader picture of Aboriginal life across the region in the decade following European settlement (Allen, Hewitt & De Lange 2008, p.45). In general, they described clans living a hunter-gatherer lifestyle, moving within their lands to make use of seasonal plant and animal resources (e.g., Thomas noted that coastal clans used to travel by canoe to French Island in the centre of Western Port Bay to obtain eggs), trading opportunities and to meet ritual and kinship obligations. More recent historical reviews challenge the idea of the hunter-gatherer, presenting evidence of Aboriginal people as land managers, deliberately nurturing the landscape to encourage specific crops and species, such as burning grasslands to encourage grassland regeneration (Pascoe 2014).

Thomas noted that favourite foods of the *Bunurong* were kangaroo and possum, and that they had the 'greatest abhorrence' for snakes (Thomas cited in Sullivan 1981, p.22). Women caught many smaller creatures such as bandicoots, rats and lizards (Thomas cited in Sullivan 1981, p.22). It is probable that many women's subsistence and other activities were not seen or recorded by Thomas, either through his lack of interest or because the women carried them out away from the presence of men.

Fires were commonly lit by Aboriginal people in the coastal area of Port Phillip and were seen by early explorers (Sullivan 1981, p.23). Fires were mainly lit to maintain pathways through dense scrub, to increase the fertility of the land, to drive game and quite probably as a smoke screen to hide behind or to warn off or confuse intruders.

Just prior to, and overlapping, the period of British exploration and settlement, the *Bunurong* were involved in a long-running dispute with the *Gunai Kurnai* people from Gippsland. According to William Barak, the conflict was a dispute over resources, which resulted in heavy casualties being suffered by the *Bunurong*. Many *Gunai Kurnai* raids occurred to abduct *Bun wurrung* women. According to Barwick (1984), the *Yowengerra* had almost been completely annihilated by 1836, largely as a result of attacks from the *Gunai Kurnai*. During 1833–1834, around 60–70 *Bunurong* people were killed in a raid by *Gunai Kurnai* while they were camped to the north of Carrum Swamp (Rhodes 2003).

In 1841, a camping reserve of 340 hectares for the *Bunurong* people was established at Mordialloc. By 1856, many of the *Bunurong* people had moved to the Mordialloc Station. The reserve continued operating until 1878, when the remaining Aboriginal people were transferred to the Mission at Coranderrk (which had opened in the 1860s), where many *Woi wurrung* people were living.

The *Bunurong/Boon wurrung* clan whose estate included the present activity area were the *Yaloke buluk* meaning river people. Their territory is thought to have been most of the eastern section of Western Port Bay (Clark 1990, p.268). Evidence of this clan is limited and includes Robinson's 1846 list of *Bunurong/Boon wurrung* clans. According to Barwick (1984, p.119), the term *Bonkoolawol*, heard by Thomas during his 1840 journey to Tobinurruck and interpreted as the name of an extinct group on the eastern shore of Western Port Bay, may have merely been a reference to this portion of the country. However, in the 1839 Census, 83 *Bunurong/Boon wurrung* members were noted. by 1846, Thomas notes that the Western Port section was 'all dead'. The Bass River was occupied in 1826–1828 by the military post cited at Corinella, and by 1835 onwards, pastoral runs were claimed by Anderson and his partner Massie (Clark 1990, p.368). In 1846 the clan leader (*Arweet*) was recorded as *Worindidjolong*, who had guided Thomas during his 1841 journey to Bass River.

There is little other specific ethnographic information of the lifestyles of the *Yaloke buluk* clan in the Lang Lang district at the time of European settlement. The few instances and recollections cited by early residents make no reference to clans or clan estates, movements or names. However, snippets of information cited within local histories can be assumed to be referring to *Yaloke buluk* clan members.

Today, the descendants of the *Bunurong* are represented today by the RAP known as the Bunurong Land Council Aboriginal Corporation (BLCAC).

Oral History Relating to the Activity Area

BLCAC was formally asked whether there is any oral history relating to the activity area. No oral history was provided.

7.2.6 Land-Use History of the Activity Area

Farm land in the Yannathan district was first sold during the 1870s. The area borders the edge of the former swamp and is a rural locality 9km east of Lang Lang. The town has remained modest in size with a school, church, post office and town hall all constructed in the late nineteenth to early twentieth centuries (Victorian Places – Yannathan 2015). Drainage of the Koo Wee Rup Swamp began by individual land owners in the mid nineteenth century before formalised large-scale drainage works were undertaken by the Public Works Department and mostly completed by 1897 (Koo Wee Rup History – A Short Overview of the Drainage of the Koo-Wee-Rup Swamp 2020). These drainage works would have assisted in flood prevention in the activity area.

As part of this assessment, historical aerial photography has been obtained. This can inform us about changes to land use over time. A 1947 aerial photograph (Figure 2) shows that the land had mostly been cleared except for one patch of potentially remnant vegetation in the south. There appears to be a driveway, signs of ploughing and the waterway appears to have been straightened already.

By 1971 (Figure 3) the remaining remnant vegetation has been cleared and there appears to be just a few trees dotted around the properties and along the waterway.

In 1990 (Figure 4) little has changed. The activity area remains grassed and there is evidence of ploughing. In this image, the areas of sand are potentially visible where the grass is browned off in the south of the study area.

More recently, much of the landscape surrounding the activity area has been subject to sand extraction and associated quarry infrastructure. The current conditions map (2019; Figure 5) shows that by far the largest impacts have occurred throughout the southern region of the activity area where sand extraction has occurred extensively since 2012. These quarry pits are extensive and represent different stages of extraction throughout the life of the quarry. This is most notable to the south of the waterway on the property. The pits are of variable size and depth. Sand extraction has subsequently had an impact on Aboriginal Places within the immediate vicinity, as indicated by the previously registered Place extents (VAHR 8021-0369, VAHR 8021-0371, VAHR 8021-0372) shown within the current quarry pit boundaries shown on Figure 5.

Two large water dams occur to the west of the central road in entering the activity area. Administration buildings, carparks and roads have been constructed within the activity area. The watercourse has evidently been modified from its original course, bypassing the large quarry pits situated to the southeast of the activity area.

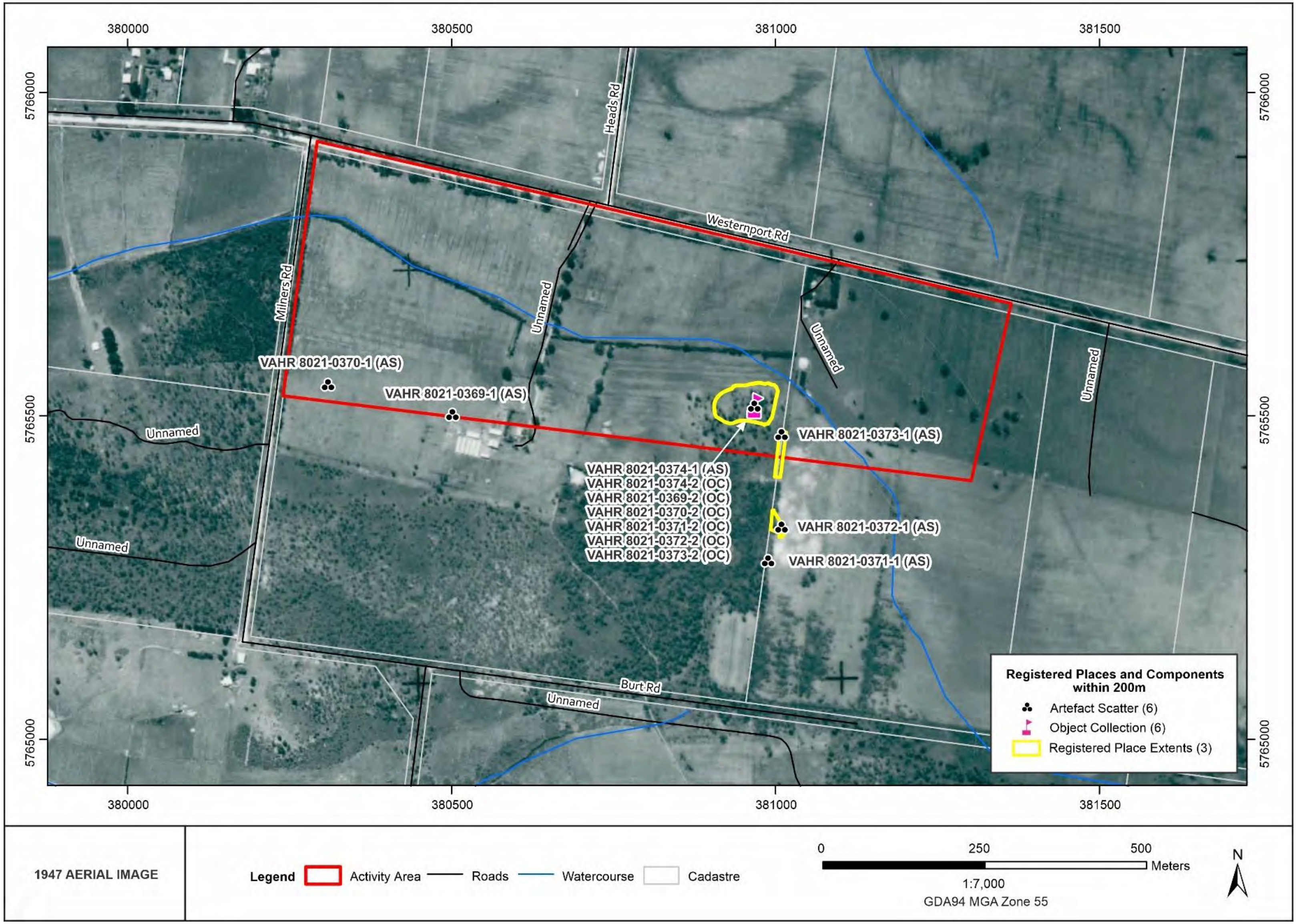


Figure 2: 1947 aerial photograph (Department of Environment, Land, Water & Planning – Maps and Services – Interactive Maps Historic Aerial Photo Maps, 2019)

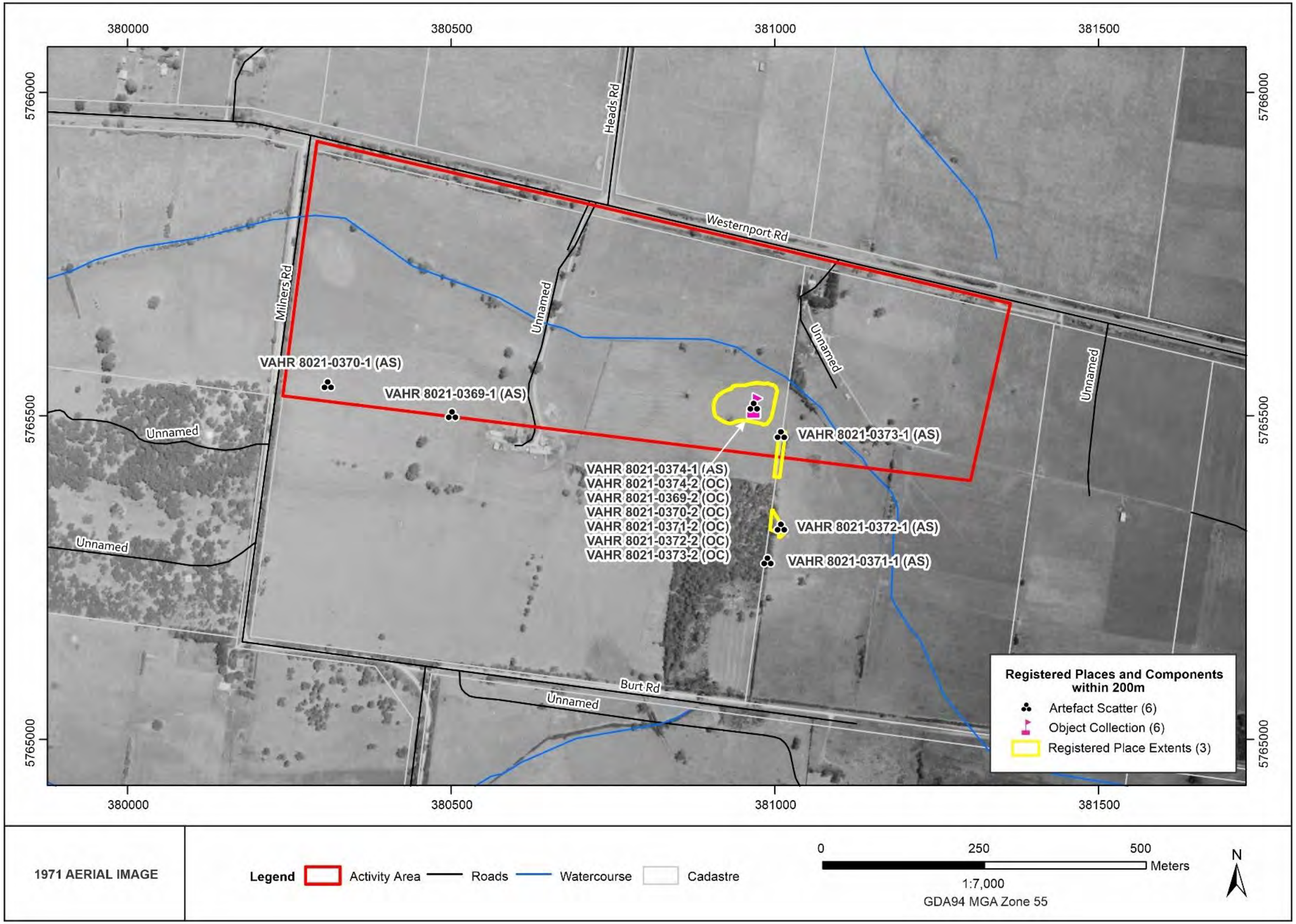


Figure 3: 1971 aerial photograph (Department of Environment, Land, Water & Planning – LANDATA 2017)

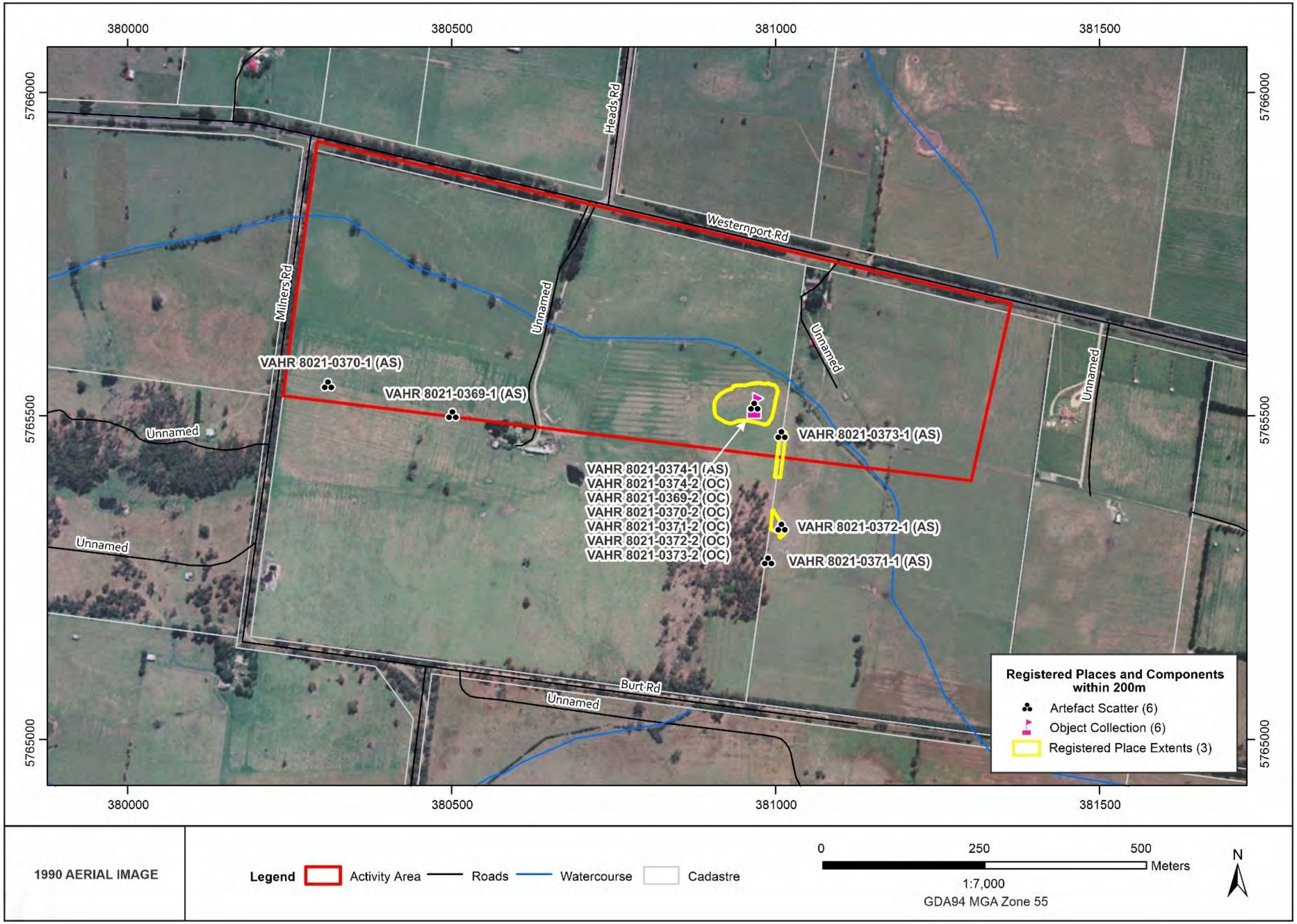


Figure 4: 1990 aerial photograph (Department of Environment, Land, Water & Planning – LANDATA 2017)

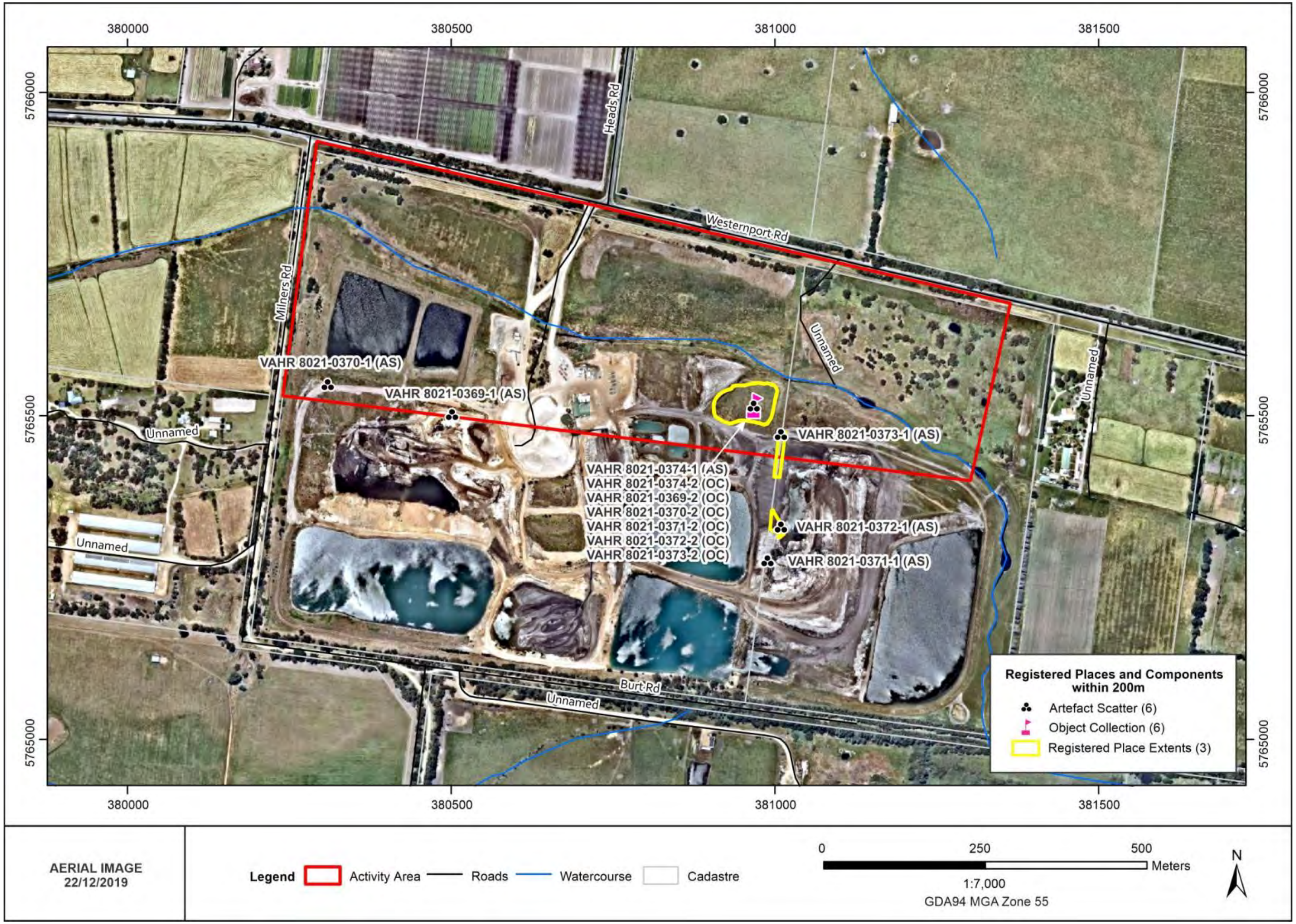


Figure 5: 2019 aerial photograph (Nearmap 2019)

7.3 Site Prediction Model

The desktop assessment for the activity area has allowed a site prediction model to be developed. A site prediction model is intended for use as an indication of the types of Aboriginal archaeological sites that may occur in a given area. The site prediction model can later be tested against the results of the field survey and/or subsurface testing. The following can be stated regarding the activity area:

- the former Lang Lang swamp (now broadly considered part of the Koo Wee Rup swamp complex) was 260m to the north of the activity area before it was drained in the early twentieth century;
- an unnamed waterway crosses the activity area from south east to north west;
- a search of the VAHR identified 21 registered Aboriginal Places within the geographic region, comprising a total of 61 components. Aboriginal Places within the geographic region, are comprised of artefact scatters, LDADs, earth features and object collections;
- the artefacts occur in varying densities from isolated stone artefacts to scatters of up to several hundred pieces. The majority occur either within sandy rises, or along waterways;
- during CHMP 11342 (Barker and McAlister 2012) in the activity area, two of the six Aboriginal Places (VAHR 8021-0369 and VAHR 8021-0370) identified within the activity area were registered as isolated artefacts. They comprised one silcrete angular fragment and one silcrete flake. The other four Aboriginal Places were recorded artefact scatter registrations (VAHR 8021-0371 to VAHR 8021-0374), comprising and 2, 12, 11, and 12 artefacts respectively. The artefacts were mostly silcrete, with minor numbers of milky quartz, quartzite and chert artefacts, and the majority are flakes or angular fragments, with only two cores;
- of the previously registered sites, VAHR 8021-0369, 8021-0370, 8021-0373, and 8021-0374 exist within the current activity area.
- all of the Places identified in the activity area were located within the sandy rise landform around the quarry site and in sandy deposits above the basal coffee rock layer;
- the likelihood of locating Aboriginal cultural material in any remaining sandy rise landforms is moderate to high; and
- aerial imagery shows the land to be cleared, and the waterway modified from as early as 1947, and after 2012 sand quarrying commenced in the southern half of the property.

Most Aboriginal Places within the geographic region are located near drainage lines, swamps and waterways within sandy rise landforms. Due to the proximity of Koo Wee Rup Swamp, the unnamed waterway and previously registered Aboriginal Places, there is potential for Aboriginal cultural heritage to be present within the activity area if there are any remaining sandy rise landforms. The most likely forms of Aboriginal cultural heritage to be present are subsurface stone artefacts appearing as either artefact scatters or low-density distributions. Scarred trees are unlikely due to previous clearance of large vegetation.

7.4 Conclusions from the Desktop Assessment

The desktop assessment has concluded that the activity area contains low-to-moderate archaeological potential. This is because the activity area is located on the margin of the elevated sandy rise landform and near the former margins of Koo Wee Rup Swamp. Previous archaeological assessment had noted that the majority of the activity area likely contains low archaeological potential within the low-lying parts of the activity area. However, there is a small sandy rise within the activity area which contains a registered Aboriginal Place and is considered an area of archaeological potential.

Regulation 62 of the *Aboriginal Heritage Regulations 2018* states that a standard assessment is required if the results of a desktop assessment show that it is reasonably possible that Aboriginal cultural heritage is present in the activity area. In this case, as there were known deposits of Aboriginal cultural heritage material within the activity area, a standard assessment was required.

8.0 Report on the Standard Assessment

In accordance with Clause 8, Schedule 2 of the *Aboriginal Heritage Regulations 2018*, this section contains the results of the standard assessment and field survey.

8.1 Aims and Methodology for the Standard Assessment

A standard assessment is a surface archaeological survey. This may locate evidence of surface sites but will not necessarily find buried archaeological deposits. The methodology for the standard assessment is informed by the desktop assessment and the site prediction model.

The aim of the field survey was to:

- identify any surface evidence of Aboriginal cultural heritage; and
- identify areas of potential sensitivity for Aboriginal cultural heritage.

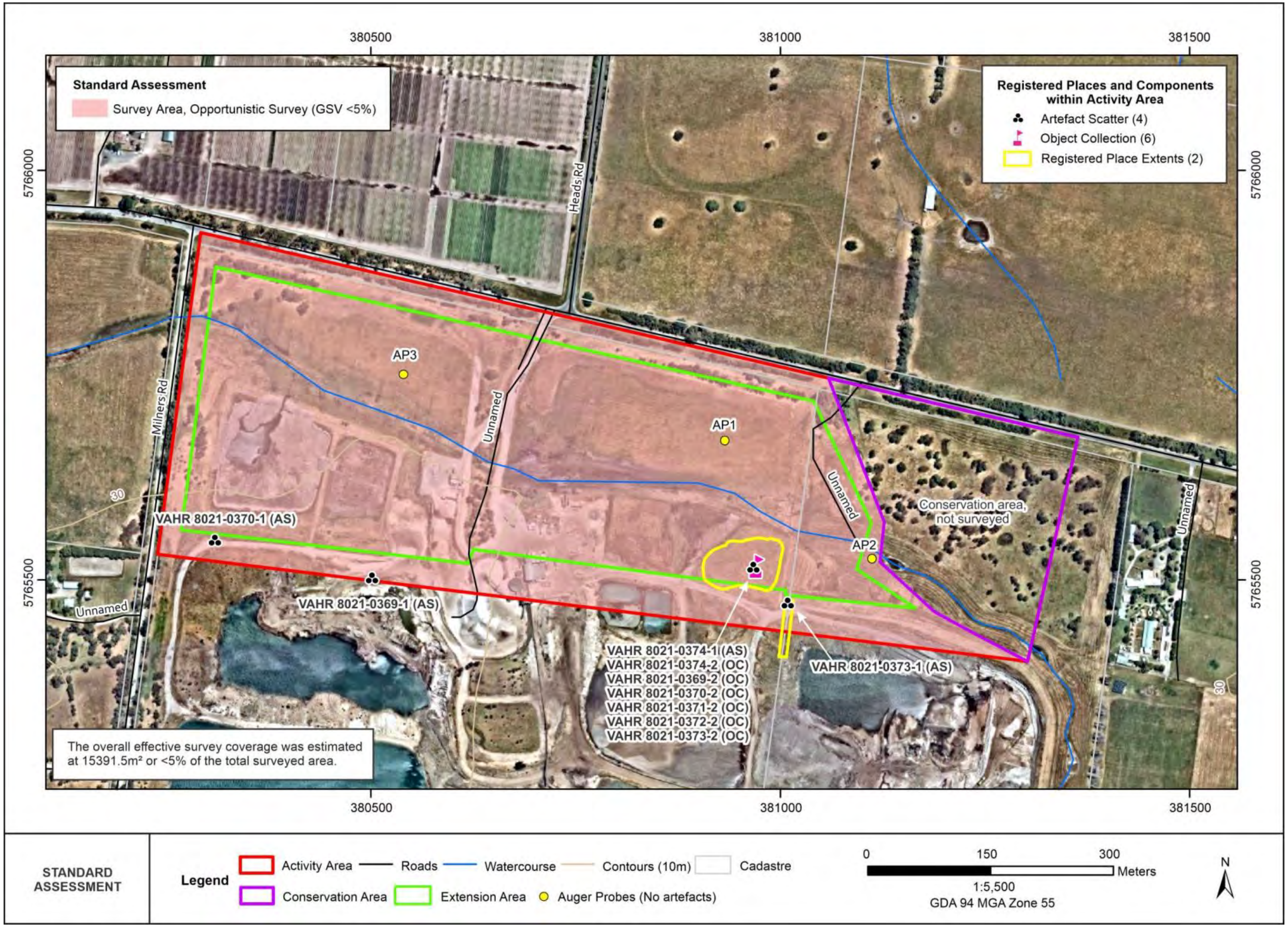
The field survey was undertaken in accordance with proper archaeological practice, pursuant to r.63 of the *Aboriginal Heritage Regulations 2018*.

The field survey comprised an opportunistic survey wherein the most of the activity area was walked: only the north eastern corner of the activity area was not included in the survey, due to its designation as an area of retention (no scheduled impacts will occur in this area); within the remaining activity area survey was limited to areas of ground surface visibility as much of the activity area was covered in dense grasses and sections were waterlogged. These areas were surveyed in east-west pedestrian transects (10m spacing) so as to ascertain areas of visibility where inspection of exposed sediments could occur.

Areas of bare ground surface exposure were inspected closely. The general percentage (%) of ground surface visibility was recorded throughout the activity area. All evidence of prior ground disturbance was also recorded. All mature trees within the activity area were examined for the presence of scars. The activity area was also examined for the presence of caves, cave entrances or rock shelters.

Three 50mm auger probes were excavated during the standard assessment. These auger probes were excavated to provide additional information about the soil profile and compare this with the information presented in CHMP 11342 (Barker & McAlister 2012) for the subsurface testing conducted within the current activity area. These were chosen based on topographic observations, with relative height being the determining factor in their target locations (Map 10 – See Section 8.2.4 for further details and results).

A discussion of the results of the survey took place on-site with the cultural heritage officer/s from the BLCAC.



Map 10: Standard assessment field survey

8.2 Results of the Standard Assessment

8.2.1 Area Surveyed

The field survey was undertaken by Renee McAlister and Simon Coxe (Heritage Insight Pty Ltd) on April 22, 2021. They were assisted by Wayne Pepper and Iris Pepper (BLCAC). Survey accessibility was reasonably good, with most of the entire activity area being open to access at the time of the standard assessment. However, several constraints and limitations were present (see below). The overall effective survey coverage was estimated at 10490m² or less than 5% of the total activity area (Map 8).

Following completion of the standard assessment, the activity area was revised to incorporate the bunds along the northern boundary and the protected environmental section in the north eastern corner. The bunds were inspected during the standard assessment as the elevated landform provided an excellent vantage point of the low-lying areas below, however the protected environmental section was not due it not being impacted by the proposed works.

8.2.2 Ground Surface Visibility and Other Constraints on Field Survey

The field survey noted several issues. While all areas were able to be accessed, the survey was inhibited by above ground 'turkey nest' dams in the south western corner of the activity area. Sections of the activity area were waterlogged, especially along the drainage line and in the southern paddocks, and covered in dense grasses, which resulted in poor ground surface visibility. Due to the north eastern corner of the activity area being scheduled for retention, no survey was conducted at this location, knowledge of Aboriginal cultural materials is therefore constrained in this area. Further constraints include the presence of two large dams in the south western corner of the activity area, which precluded survey within this area.

Photography was taken with both a camera and a drone: as such, a scale bar is not present in imagery taken with the drone. Despite the lack of a scale bar, it is considered many of the drone images give a better view of the overall landscape.

8.2.3 Survey Results

The survey area is a roughly rectangular-shaped area to the north of a working quarry. The south western corner of the activity area is characterised by two large dams. These dams are elevated above the natural ground surface (Plates 1 and 3) and as such, survey of the original ground surface was not possible. The north western corner of the activity area is characterised by a large rectangular shaped open paddock that is covered in pastoral grasses. A small drainage line runs through this paddock. The ground surface was extremely waterlogged either side of the drainage line (Plate 2) and thick pastoral grasses meant ground surface visibility in this area was extremely low (Plates 2–6). This paddock contains few trees. All were inspected, but none are considered suitable for cultural scarring. In the northern section of the paddock, large bunds approximately 2–3m high have been constructed as part of the quarry operations.

Throughout the central section of the activity area runs the access road, a gravel road, a weigh bridge, parking area and site offices. To the south of the site office is part of the working quarry, with a large shed, roads and loading area. This whole section has undergone high levels of disturbance associated with the construction of facilities and day to day operations of the quarry (Plate 10).

The central paddock is much the same as the western paddock, with dense pastoral grasses and high levels of waterlogging around the drainage line (Plates 7–8). Visibility was extremely poor through this area. This area has been impacted through ploughing, installation of underground power lines and the construction of bunds along the northern edge.

A small sandy rise is present in southern central section of the activity area. This area was identified as a protected heritage zone within CHMP 11342 (Barker & McAlister 2012) and has been fenced off. Aboriginal Place VAHR 8021-0374 is located within this area, with the site extent being mapped as the extent of the sandy rises (Plate 9). This area has also been utilised for the reburial of other Aboriginal Places associated with CHMP 11342 (Barker & McAlister 2012).

The eastern section of the activity area is characterised by a highly modified drainage line and series of drainage ponds. Substantial ground disturbance has likely occurred in this area with the removal of top soil and shaping for the drainage line (Plates 11–14).

No areas of archaeological potential, outside of the protected heritage zone were identified.

Map 10 shows conditions in the survey area and Plates 1–14 below show conditions in the survey area.

Plate 1: Aerial view of turkey nest dams in south western corner of activity area, facing south west (photo by R McAlister, 22/4/21)

Plate 2: Aerial view of north western paddock in activity area, note waterlogged soils, facing north west (photo by R McAlister, 22/4/21)

Plate 3: Bank of turkey nest dam, facing west (photo by R McAlister, 22/4/21)

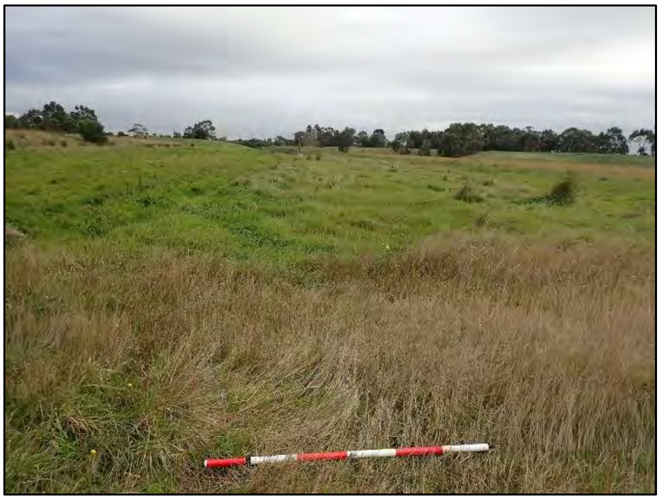


Plate 4: Waterlogged western paddock and drainage line facing west (photo by R McAlister, 22/4/21)

Plate 5: Western paddock from the top of the bunds, facing south (photo by R McAlister, 22/4/21)

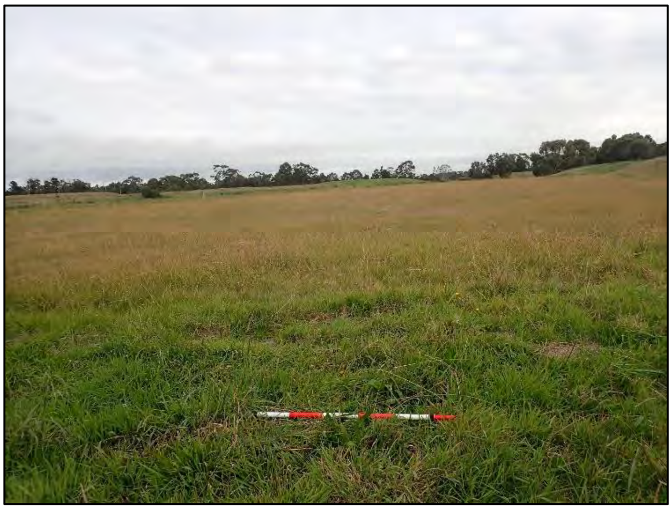


Plate 6: Western paddock, facing west (photo by R McAlister, 22/4/21)

Plate 7: Aerial view of central paddock, facing west (photo by R McAlister, 22/4/21)

Plate 8: Waterlogged western corner of central paddock, facing east (photo by R McAlister, 22/4/21)

Plate 9: Aerial view of protected heritage zone, facing south (photo by R McAlister, 22/4/21)

Plate 10: Aerial view of activity area, facing east (photo by R McAlister, 22/4/21)

Plate 11: Aerial view of eastern end of activity area, facing east (photo by R McAlister, 22/4/21)

Plate 12: View across eastern paddock, note drainage line, facing east (photo by R McAlister, 22/4/21)

Plate 13: Modified drainage line in eastern paddock, facing west (photo by R McAlister, 22/4/21)

Plate 14: Drainage line in eastern paddock, facing west (photo by R McAlister, 22/4/21)

8.2.4 Auger Probes

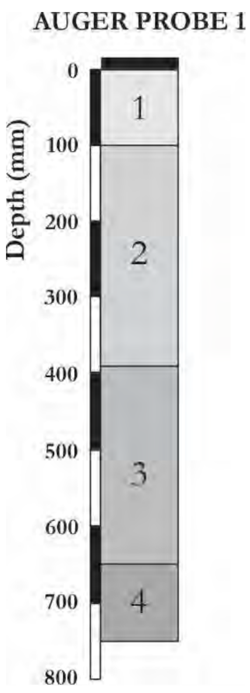
Three 50mm auger probes were excavated during the standard assessment. These auger probes were excavated to provide additional information about the soil profile and compare this with the information presented in CHMP 11342 (Barker & McAlister 2012) for the subsurface testing conducted within the current activity area. These were chosen based on topographic observations, with relative height being the determining factor in their target locations (Map 10).

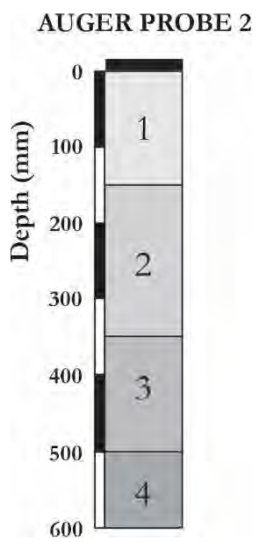
APs 1–3 showed variable soil profile results but all are indicative of ground disturbance in this area. AP 1 showed sandy loam, overlaying loamy sand, over sand, overlaying sandy clay at an approximate depth of 650mm. AP 2 showed silty loam topsoil deposits, overlaying sandy loam, with sandy clay deposits being located at approximately 500mm. AP 3 showed a similar soil profile to AP 1 with sandy clay emerging at approximately 770mm.

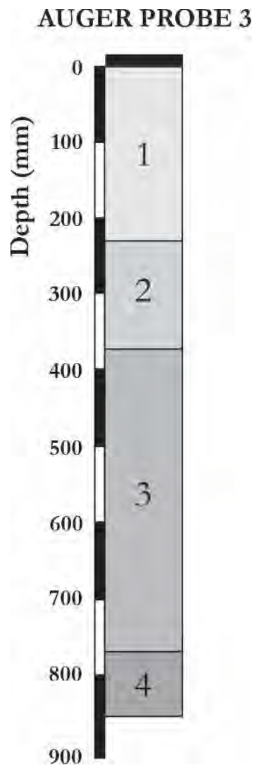
While limited information on soil testing in the current activity area is presented in CHMP 11342 (Barker & McAlister 2012), it notes that test pits within the low-lying northern paddocks were characterised by deposits of very dark grey heavy waterlogged silty sandy clay to an average depth of 700–800mm. This is indicative of extremely waterlogged soils. STP testing within the north eastern corner for CHMP 11342 revealed generally shallow deposits of silty clay over clay. More testing was required to investigate the discrepancy in the CHMP results with the auger probe results. It is considered likely that the waterlogged nature of the soil deposits is a factor.

Auger probe results are presented in Table 6 below and the location of the auger probes is shown on Map 10.

Table 6: Summary results of auger probe testing

STP	GDA 94 Coordinates (Zone 55)	Artefacts	Context	Stratigraphy	Photos
1	380932.532E 5765669.690N	None	**Context 1** 0–100mm: Moderately compacted, moist sandy loam with roots. Small, angular, blocky structure. Munsell: 10YR 3/1 (very dark grey), pH: 4.5. **Context 2** 100–390mm: Loose, dry loamy sand. Single -grained structure. Munsell: 10YR 5/2 (greyish-brown), pH: 4. **Context 3** 390–650mm: Loose, dry, fine-grained sand. Single grained structure. Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5. **Context 4** 650–750mm: Firm, dry, mottled sandy clay. Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5.		 

STP	GDA 94 Coordinates (Zone 55)	Artefacts	Context	Stratigraphy	Photos
2	381112.117E 5765525.451N	None	**Context 1** 0–150mm: Loose, moist silty-loam with roots. Small, angular, blocky structure. Munsell: 10YR 3/1 (very dark grey), pH: 5.5. **Context 2** 150–350mm: Loose, moist, humic, medium-grained sandy loam. Poorly sorted structure. Munsell: 5YR 2.5/1 (black), pH: 5.5. **Context 3** 350–500mm: Loose, dry, fine-grained sand. Single grained structure. Coffee rock at top of horizon. Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.5. **Context 4** 500–600mm: Firm, dry, mottled sandy clay. Munsell: 2.5Y 7/4 (pale brown), pH: 5.5.		 

STP	GDA 94 Coordinates (Zone 55)	Artefacts	Context	Stratigraphy	Photos
3	380539.625E 5765750.388N	None	**Context 1** 0–230mm: Moderately compacted, moist sandy loam with roots. Small, angular, blocky structure. Munsell: 10YR 3/1 (very dark grey), pH: 4.5. **Context 2** 230–370mm: Loose, dry loamy sand. Single grained structure. Munsell: 10YR 5/2 (greyish-brown), pH: 4. **Context 3** 370–770mm: Loose, dry, fine-grained sand. Single grained structure. Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5. **Context 4** 770–850mm: Firm, dry, mottled sandy clay. Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5.		 

8.2.5 Aboriginal Cultural Heritage

Aboriginal Place VAHR 8021-0374 is located within the activity area. This area is currently fenced off and marked as a heritage protection zone (Plate 9). This Aboriginal Place is a subsurface artefact scatter. This is also the reburial location for Aboriginal Places VAHR 8021-0369 to VAHR 8021-0373. No Aboriginal cultural material was located during this survey.

8.2.6 Areas of Potential Archaeological Sensitivity

No areas of moderate to high archaeological potential were identified, other than the sandy rise that comprises the heritage protection zone.

8.3 Conclusions from the Standard Assessment

The standard assessment did not locate any caves, cave entrances, rock formations or scarred trees.

The desktop assessment noted that the activity area likely contained low archaeological potential for the discovery of cultural heritage material. The activity area did not contain any other prominent sandy rises, comparable to the previously assessed VAHR 8021-0374, overlooking the (now modified) creek which may have contained higher archaeological potential.

No surface deposits of Aboriginal cultural material were located. The southern section of the activity area has been impacted by disturbance associated with quarrying activities, along with the central section and the northern bunds. The low-lying paddocks between the bunds and the quarry are waterlogged and were considered to contain low archaeological potential given their proximity to known Aboriginal Places and former swamp margins, however it was considered likely that any Aboriginal cultural material found would involve disturbed deposits of low densities of stone material.

A complex assessment is required when Aboriginal cultural material is, or is likely to be, present in the activity area and it is not possible to identify the nature, extent and significance of that material, as per **r.64** of the *Aboriginal Heritage Regulations 2018*. While the nature, extent and significance of VAHR 8021-0374 is known, the BLCAC requested that additional complex assessment testing occur to more fully understand the archaeological potential of the low-lying paddocks within the activity area, given the limited nature of previous testing that had occurred on this landform.

9.0 Report on the Complex Assessment

In accordance with Clause 8, Schedule 2 and Clause 9, Schedule 2 of the *Aboriginal Heritage Regulations 2018*, this section contains the results of the complex assessment.

9.1 Aims and Methodology for the Complex Assessment

The objective of the complex assessment was to test all landforms for the presence or absence of cultural material and ascertain what potential impacts the continued extraction of sand will have on these heritage values. As well as undertaking sampling to assess proposed impact areas for Aboriginal cultural heritage, the excavations also provided information regarding any soil disturbance within the activity area that would affect the preservation of subsurface Aboriginal cultural heritage sites. The complex assessment methodology was developed in consultation with the Bunurong Land Council and Aboriginal Corporation (BLCAC).

A complex assessment (subsurface testing by excavation) was carried out as part of this assessment between September 7, 2021 to November 16, 2021 and was supervised by a qualified archaeologist (Simon Coxe of Heritage Insight Pty Ltd). A brief discussion of the results of the complex assessment took place on-site with the cultural heritage officers from the BLCAC.

Machine Transects

Machine excavation of a series of 2x1m trenches (MTPs) were conducted in a linear transect approximately spaced in 50m intervals along an east west axis (see Map 11). Machine trenches (MTPs) were excavated to further assess the likelihood of Aboriginal cultural material being located within the activity area and to provide a more extensive sample of the surface and subsurface soils. The use of machine test pits for the majority of the testing program was undertaken to expedite the excavation process due to the size of the activity area and depth of deposits. The MTPs were labelled numerically and sequentially.

Initially, the grass layer was stripped off each transect to a depth of approximately 5cm with a 1m mud bucket. Soil within the MTPs was then excavated in increments of approximately 10cm in order to provide a good profile of the horizontal and vertical distribution of any cultural remains identified through the different soil layers. This process continued until the presence of the sterile basal layer was located. All of the sediments from the MTPs were passed through a mechanical sieve with a 5mm mesh.

Soil sections were drawn of one wall of each MTP once excavation was completed. A photographic record of the surface, any features identified during excavation and the soil section was made. A range pole with increments of 20cm was included in all photographs. Soil descriptions and other natural and cultural features were recorded on standard excavation forms. Soil descriptions were based on the Australian Soil Classifications and the standard Munsell Soil Chart. Soil pH levels were taken for each spit and soil context using a standard garden variety test kit.

Coordinates for the location of each MTP were recorded using a differential GPS and backfilling took place in order to comply with OH&S requirements.

Map 11: Subsurface testing locations

9.2 Constraints on the Complex Assessment

Works were initially scheduled to start September 7, 2021. However, ground conditions were considered too wet after several bouts of heavy rainfall during the previous weeks. Consultation between the BLCAC cultural heritage officers and Simon Coxe (HI) concluded that saturated ground conditions was both unsafe and detrimental to assessing the probability of Aboriginal cultural materials being present. Works ceased after only one day (September 7, 2021) and were rescheduled for September 20–23, 2021. However, due to COVID-19 restrictions (cessation of non-essential works), work ceased after two days (September 20–21). Work was rescheduled for November 15–16, 2021, whereupon the testing programme was completed, despite continued wet ground conditions, specifically in the low-lying areas of the flood plain. Because of this, the 1x1m test pit, originally due to be excavated on the flood plain, was not undertaken after consultation with the BLCAC (see Section 6.0). The remaining trenches were situated on higher ground with better drained soils, although even at these locations sieving conditions remained poor.

9.3 Results of the Complex Assessment

The complex assessment was conducted between September 7, 2021 and November 16, 2021 by Simon Coxe, Nick Stebbins and Paul Chalice (Heritage Insight Pty Ltd) with assistance from Iris Pepper, Wayne Pepper, Minta Franks and Richard Cole (CHO, BLCAC).

A total of 12 machine trenches were excavated across the activity area in order to assess the likelihood of Aboriginal cultural material being present and to establish a profile of the soils within the activity area. The results of the excavation are outlined below. No suitable samples were available for scientific dating of the soil deposit.

9.3.1 Machine Transects

A total of 12 2x1m machine test pits (MTPs 1–12) were excavated in a near linear transect along the east-west axis of the activity area (Table 1). MTPs 1–8 all showed the same soils profile (with minor variations in depth and thickness of horizons); MTPs 9 and 10 revealed a distinctly different soil profile that the previous test trenches; MTPs 11 and 12 showed slightly different soil profiles compared with MTPs 1–8 but are otherwise comparable in terms of depth and horizon thickness. These differences and their implications are discussed below (Section 9.4).

MTPs 1–8 were excavated in a transect with approximately 50m between test trenches, where conditions permitted. MTPs 1–4 were excavated in the western paddock and MTPs 5–8 were excavated in the eastern paddock, with the main access road into the quarry site bisecting the two paddocks. All of these trenches are located on an open alluvial plain the north of the highly modified channel that runs north west to south east through the activity area.

The soil profile observed within MTPs 1–8 are clearly part of the Alluvium (Qa1) formation, which lies at the margins of the Coastal Dune (Qdl1) formation, mapped in the southern margin of the activity area (Map 5).

The stratigraphic profile revealed an upper horizon described as moderately compacted, friable, wet, angular, blocky structured sandy loam with abundant small roots. The very dark grey sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 2, is smooth and sharp. Context 2 is a loose, friable, wet, single grained structured loamy sand. The greyish-brown sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 3, is wavy and diffuse. Context 3 is described as weakly compacted, very friable, dry single grained-structured sand with rare small roots. The light brownish-grey sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 4, is sharp and smooth. Context 4 is described as firmly compacted, very friable, wet, medium angular blocky structured sandy clay. The mottled light grey and yellow sediments within this horizon are well sorted with no obvious stony inclusions. The light grey colouring indicates gleyification of the sediments which suggests that waterlogged and anaerobic conditions are prevalent throughout this part of the activity area.

MTPs 9–10 were excavated perpendicular to the east-west axis of the transect, with MTP 9 located approximately 10m to the north of MTP 10. MTP 9 is situated on the northern (right) bank of the modified channel, whereas MTP 9 is situated within the channel. This was done to observe the degree of truncation to the original ground surface. The results show that within the channel no intact sediments remain, with removal of all horizons down to the underlying (basal) sandy clay. Part of MTP 9 also showed evidence of truncation resulting from the modification of the channel.

The soil profile observed within MTPs 9–10 is also part of the Alluvium (Qa1) formation, but at this location the sediments (taken primarily from MTP 9) are somewhat different to those observed in MTPs 1–8, suggesting a differing geomorphic and pedogenic history (see Section 9.4).

The stratigraphic profile within MTP 9 revealed an upper horizon described as loosely compacted, very friable, moist, single grained structured silty sand with abundant small roots. The black sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 2, is smooth and clear. Context 2 is a loose, friable, moist, single grained-structured sand. The grey sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 3, is wavy and abrupt. Context 3 is described as loosely compacted, very friable, wet single grained-structured sand with rare small roots. The light brownish-grey sediments within this horizon are poorly sorted with common inclusions of sub-rounded 'coffee' rock pebbles and cobbles. The boundary with the next horizons, Context 4 and Context 5, is diffuse and wavy. Context 4 is described as loosely compacted, friable, wet, single grained-structured sand. The dark brown sediments within this horizon are well sorted with no obvious stony inclusions or 'coffee rock'. The boundary with the next horizon, Context 5, is sharp and wavy. Context 5 is described as indurated, dry single grained-structured clay sand with rare small roots. The mottled light yellow-brown and yellow-brown sediments within this horizon are well sorted with no obvious stony inclusions. The nature of the sediments suggest that this is a B horizon that ultimately overlies tertiary sands at a greater depth.

The soil profile revealed in MTP 10 conforms to the lower part of the profile recorded in MTP 9.

MTPs 11–12 were excavated approximately 100m to the east of MTPs 9 and 10. Both trenches are situated on the north (right) bank of the modified channel, albeit slightly further away when compared to MTPs 9 and 10, but still in relative proximity.

The soil profile observed within MTPs 11–12 are also part of the Alluvium (Qa1) formation. As with MTPs 9 and 10, the sediments at this location are somewhat different to those observed in MTPs 1–8, again suggesting a differing geomorphic and pedogenic history (see Section 9.4).

The stratigraphic profile within MTPs 11–12 revealed an upper horizon, described as moderately compacted, friable, wet, small sub-angular blocky structured sandy silt with abundant small roots. The very dark brown sediments within this horizon are moderately sorted with stony inclusions of rare small quartz rounded pebbles. The boundary with the next horizon, Context 2, is smooth and sharp. Context 2 is a loose, friable, wet, single grained-structured loamy sand. The black sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 3, is wavy and diffuse. Context 3 is described as loosely compacted, very friable, wet single grained-structured fine-grained sand. The grey sediments within this horizon are well sorted with no obvious stony inclusions. The boundary with the next horizon, Context 4, is abrupt and wavy. Context 4 is described as firmly compacted, wet, medium angular blocky structured sandy clay. The light grey and yellow sediments within this horizon are well sorted with no obvious stony inclusions. As with MTPs 1–8, this suggests gleyification of sediments at this location.

Table 7: Testing summary – Machine Test Pit 1

Machine Test Pit 1			
Dimension	2x1m	**Landform**	Flood plain
Depth of Excavation	640mm		
Evidence of Disturbance	None noted		
GDA 94 Coordinates (Zone 55)	380363.177E/ 5765839.452N		
Aboriginal Cultural Heritage	None		
Soil Description			
Context 1 (A1) 0–80mm: Moderately compacted, friable, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2. Munsell: 10YR 3/1 (very dark grey), pH: 4.5. **Context 2 (A2E)** 80–410mm: Loose and friable, wet, loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3. Munsell: 10YR 5/2 (greyish-brown), pH: 4. **Context 3 (B1)** 410–640mm: Loose and friable, wet, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4. Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5. **Context 4 (B2)** 640+mm: Firm, wet, mottled sandy clay. Medium angular blocky structure. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location). Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5			

Figure 6: Machine Test Pit 1, section drawing (north wall)

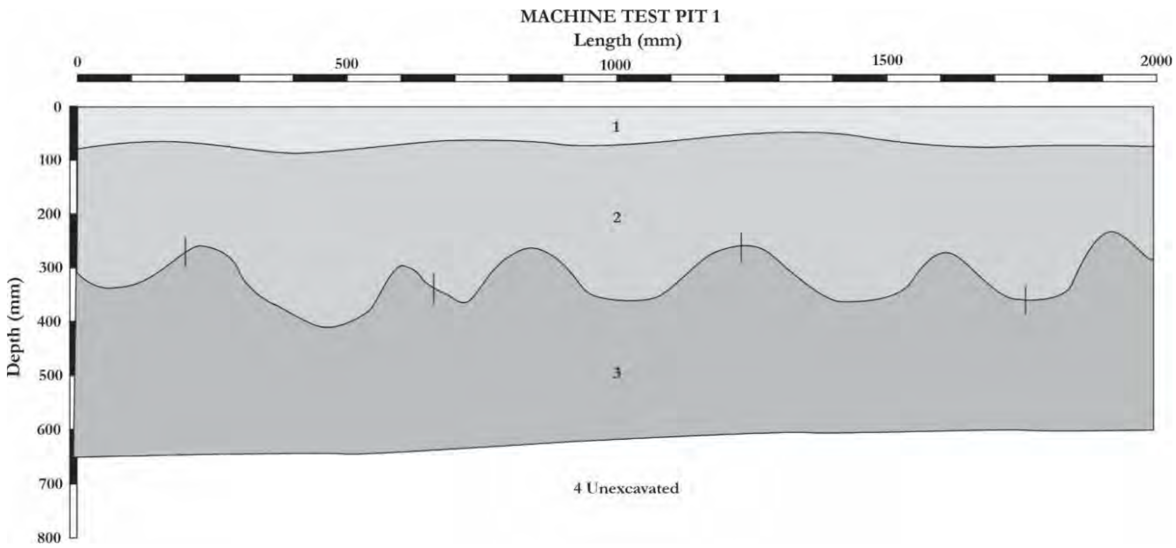


Plate 15: Machine Test Pit 1, north wall, by S Coxe, 20/9/2021

Table 8: Testing summary – Machine Test Pit 2

Machine Test Pit 2			
Dimension	2x1m	**Landform**	Flood plain
Depth of Excavation	700mm		
Evidence of Disturbance	None noted		
GDA 94 Coordinates (Zone 55)	380405.91E/ 5765816.671N		
Aboriginal Cultural Heritage	None		
Soil Description			
Context 1 (A1) 0–290mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2. Munsell: 10YR 3/1 (very dark grey), pH: 4.5. **Context 2 (A2E)** 290–580mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3. Munsell: 10YR 5/2 (greyish-brown), pH: 4. **Context 3 (B1)** 580–700mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4. Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5. **Context 4 (B2)** 700+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location). Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5			
Figure 7: Machine Test Pit 2, section drawing (north wall)			

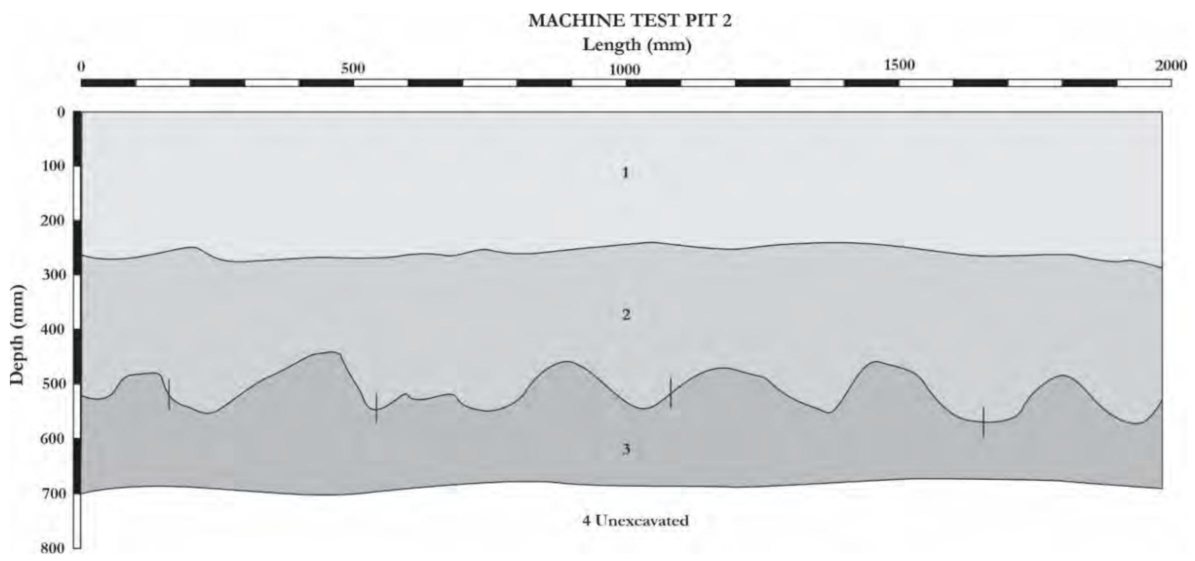


Plate 16: Photo of Machine Test Pit 2, north wall, by S Coxe, 20/9/2021

Table 9: Testing summary – Machine Test Pit 3

Machine Test Pit 3			
Dimension	2x1m	**Landform**	Flood plain
Depth of Excavation	600mm		
Evidence of Disturbance	None noted		
GDA 94 Coordinates (Zone 55)	380504.788E/ 5765785.232N		
Aboriginal Cultural Heritage	None		
Soil Description			
Context 1 (A1) 0–190mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2. Munsell: 10YR 3/1 (very dark grey), pH: 4.5. **Context 2 (A2E)** 190–420/570mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3. Munsell: 10YR 5/2 (greyish-brown), pH: 4.			

Context 3 (B1) 420/570–600mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4.
Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.

Context 4 (B2) 600+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5

Figure 8: Machine Test Pit 3, section drawing (north wall)

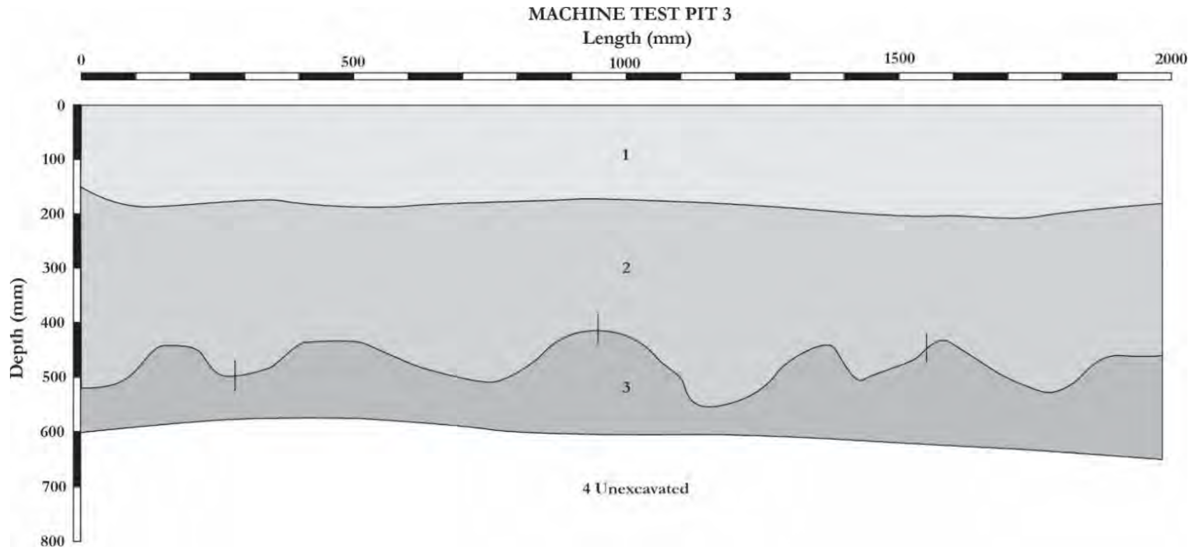


Plate 17: Machine Test Pit 3, north wall, by S Coxe, 20/9/2021

Table 10: Testing summary – Machine Test Pit 4

<table>
<tr><th colspan="4">Machine Test Pit 4</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Flood plain</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">1000mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">380579.570E/ 5765756.469N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><th colspan="4">Soil Description</th></tr>
<tr><td colspan="4">Context 1 (A1) 0–120mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2.
Munsell: 10YR 3/1 (very dark grey), pH: 4.5.

Context 2 (A2E) 120–530mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.</td></tr>
</table>

Munsell: 10YR 5/2 (greyish-brown), pH: 4.

Context 3 (B1) 530–1000mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4.
Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.

Context 4(B2) 1000+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5

Figure 9: Machine Test Pit 4, section drawing (north wall)

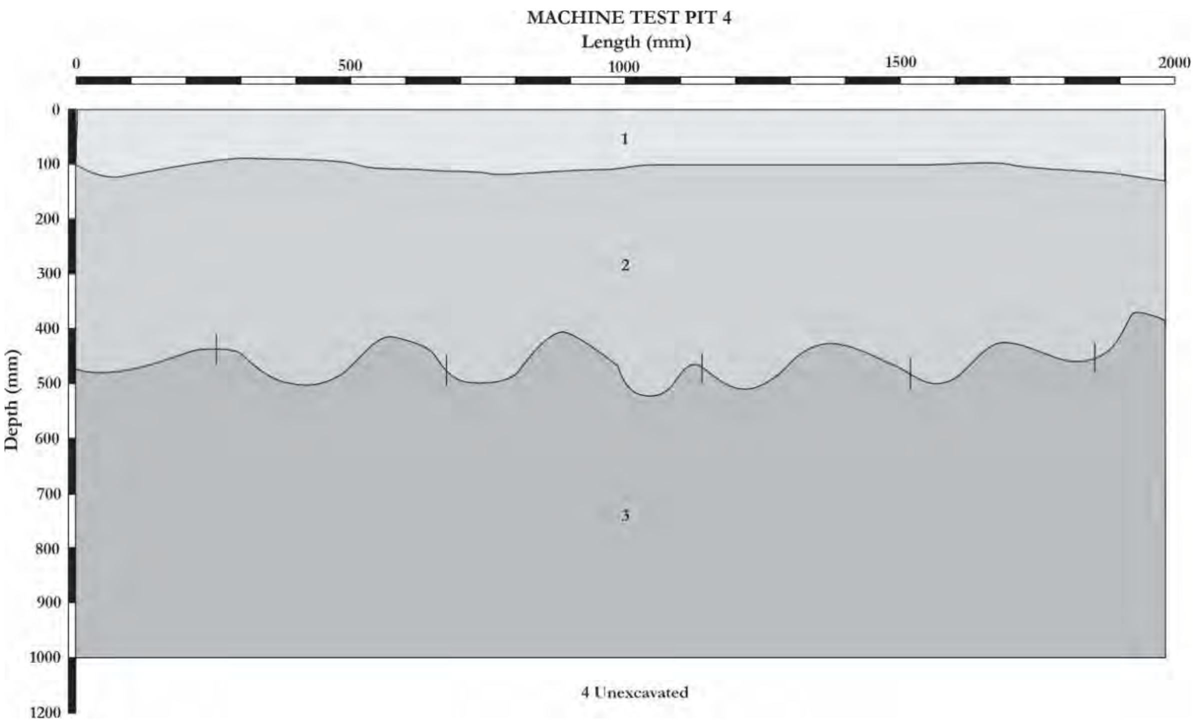


Plate 18: Machine Test Pit 4, north wall, by S Coxe, 20/9/2021

Table 11: Testing summary – Machine Test Pit 5

<table>
<tr><th colspan="4">Machine Test Pit 5</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Flood plain</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">610mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">380815.911E/ 5765690.374N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><th colspan="4">Soil Description</th></tr>
<tr><td colspan="4">Context 1 (A1) 0–90mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2.
Munsell: 10YR 3/1 (very dark grey), pH: 4.5.

Context 2 (A2E) 90–470mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.
Munsell: 10YR 5/2 (greyish-brown), pH: 4.</td></tr>
</table>

Context 3 (B1) 470–610mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4.
Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.

Context 4 (B2) 610+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5

Figure 10: Machine Test Pit 5, section drawing (north wall)

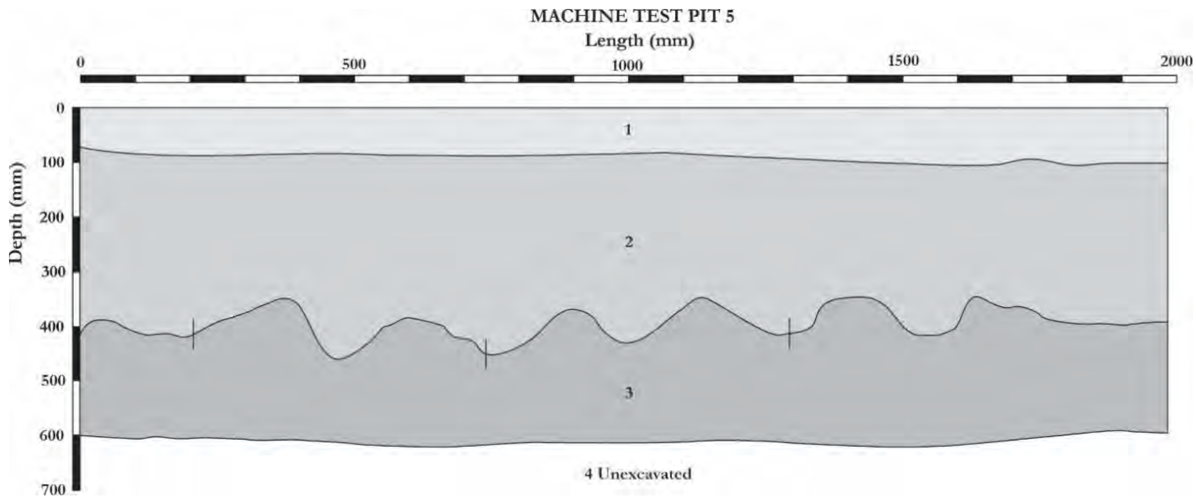


Plate 19: Machine Test Pit 5, north wall, by S Coxe, 20/9/2021

Table 12: Testing summary – Machine Test Pit 6

<table>
<tr><th colspan="4">Machine Test Pit 6</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Flood plain</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">700mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">380874.870E/ 5765681.080N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><th colspan="4">Soil Description</th></tr>
<tr><td colspan="4">Context 1 (A1) 0–130mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2.
Munsell: 10YR 3/1 (very dark grey), pH: 4.5.

Context 2 (A2E) 130–480mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.
Munsell: 10YR 5/2 (greyish-brown), pH: 4.</td></tr>
</table>

Context 3 (B1) 480–700mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4.
Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.

Context 4 (B2) 700+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5

Figure 11: Machine Test Pit 6, section drawing (north wall)

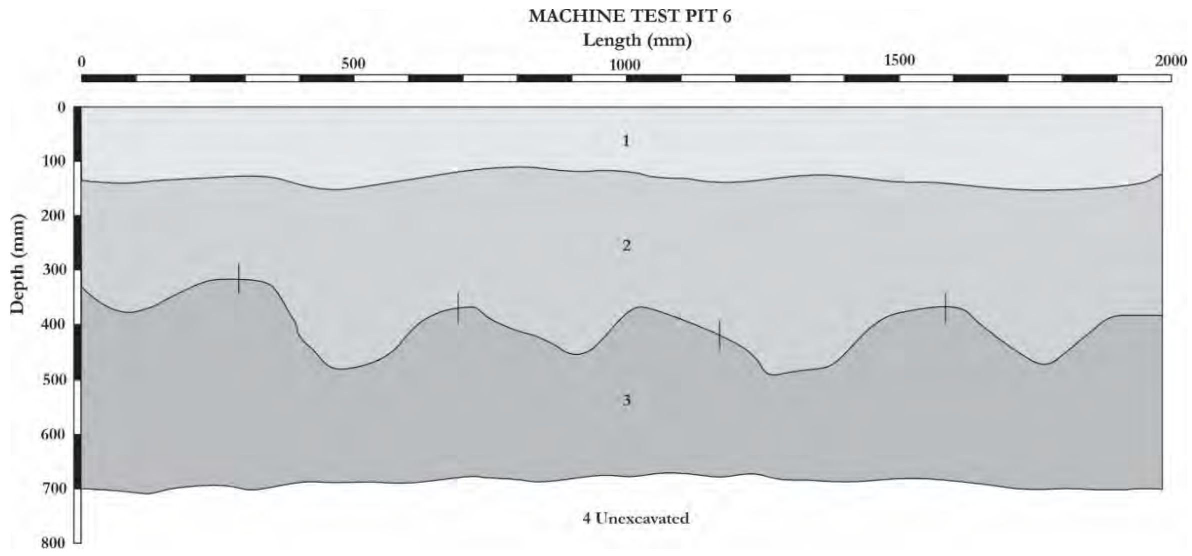


Plate 20: Machine Test Pit 6, north wall, by S Coxe, 21/9/2021


Table 13: Testing summary – Machine Test Pit 7

<table>
<tr><th colspan="4">Machine Test Pit 7</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Flood plain</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">600mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">380946.624E/ 5765668.075N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><th colspan="4">Soil Description</th></tr>
<tr><td colspan="4">Context 1 (A1) 0–130mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2.
Munsell: 10YR 3/1 (very dark grey), pH: 4.5.

Context 2 (A2E) 130–500mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.
Munsell: 10YR 5/2 (greyish-brown), pH: 4.</td></tr>
</table>

Context 3 (B1) 500–600mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4.
Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.

Context 4 (B2) 600+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5

Figure 12: Machine Test Pit 7, section drawing (north wall)

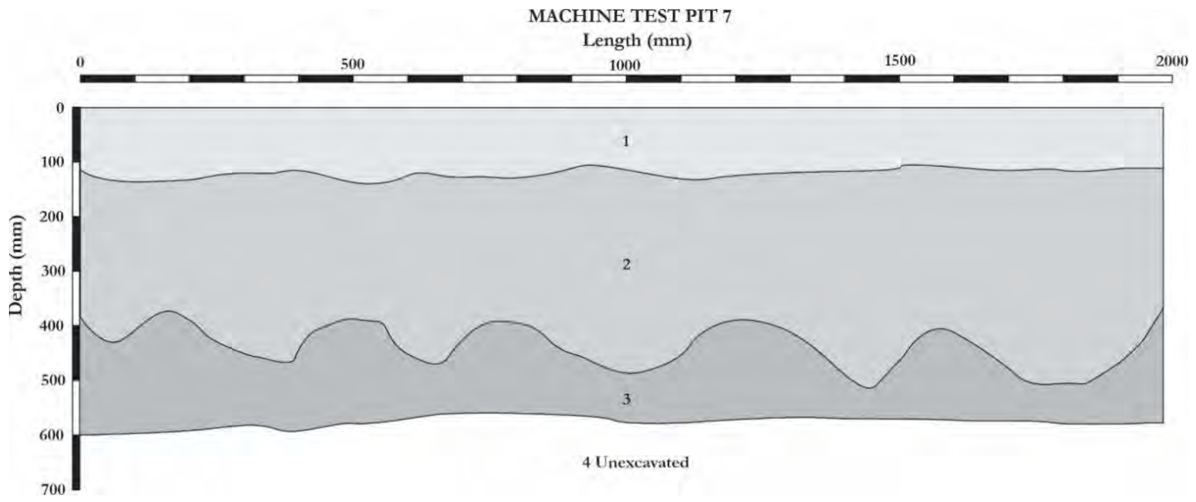


Plate 21: Machine Test Pit 7, north wall, by S Coxe, 21/9/2021

Table 14: Testing summary – Machine Test Pit 8

<table>
<tr><th colspan="4">Machine Test Pit 8</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Flood plain</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">900mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">381003.336E/ 5765624.491N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><td colspan="4">Soil Description</td></tr>
<tr><td colspan="4">Context 1 (A1) 0–90mm: Moderately compacted, wet sandy loam with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2.
Munsell: 10YR 3/1 (very dark grey), pH: 4.5.

Context 2 (A2E) 90–780mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.
Munsell: 10YR 5/2 (greyish-brown), pH: 4.</td></tr>
</table>

Context 3 (B1) 780–900mm: Loose, dry, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Sharp and smooth boundary with Context 4.
Munsell: 2.5Y 6/2 (light brownish-grey), pH: 5.

Context 4 (B2) 900+mm: Firm, wet, mottled sandy clay. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 5Y 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 6.5

Figure 13: Machine Test Pit 8, section drawing (north wall)

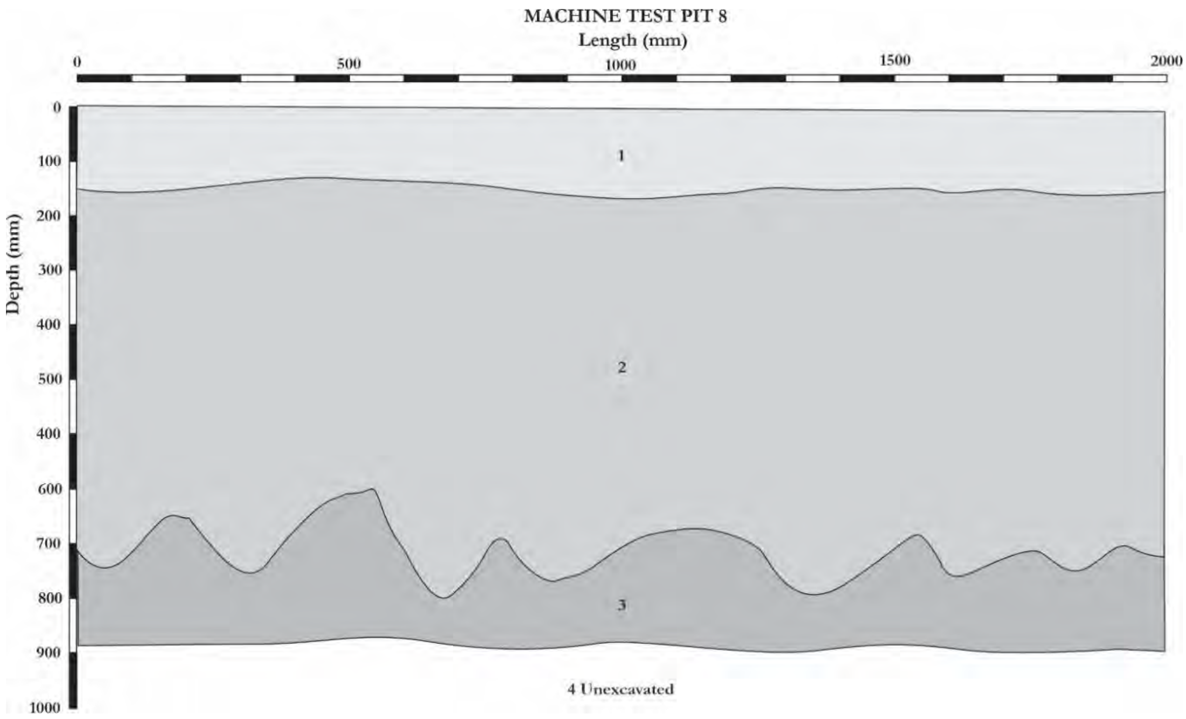


Plate 22: Machine Test Pit 8, north wall, by S Coxe, 21/9/2021

Table 15: Testing summary – Machine Test Pit 9

Machine Test Pit 9			
Dimension	2x1m	**Landform**	Creek line
Depth of Excavation	1100mm		
Evidence of Disturbance	None noted		
GDA 94 Coordinates (Zone 55)	381115.435E/ 5765561.553N		
Aboriginal Cultural Heritage	None		
Soil Description			
Context 1A 0–100mm: Loosely compacted, very friable, moist silty sand with abundant small roots. Single grained structure. Poorly sorted with no obvious stony inclusions but redeposited subsoils from channel modification. Smooth and clear boundary with Context 1. Munsell: 7.5YR 2.5/1 (black), pH: 5.5			

Context 1 (A1) 100–360mm: Loosely compacted, very friable, moist silty sand with abundant small roots. Single grained structure. Well sorted with no obvious stony inclusions. Sand at this location is coarser than that observed in MTPs 1–8. Smooth and clear boundary with Context 2.
Munsell: 7.5YR 2.5/1 (black), pH: 5.5

Context 2 (A2E) 360–690mm: Loose, and friable moist sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and abrupt boundary with Context 3.
Munsell: 7.5YR 5/1 (grey), pH: 6

Context 3 (B1) 690–810mm: Loose, moist, friable sand. Single grained structure, poorly sorted, with common inclusions of sub-rounded 'coffee' rock pebbles and cobbles. Diffuse and wavy boundary with Contexts 4 and 5.
Munsell: 7.5Y 3/2 (dark brown), pH: 6

Context 4 (lens) 800–1050mm: Loose, moist, friable sand. Single grained structure, well sorted with no obvious stony inclusions or 'coffee rock'. Possibly evidence of prior root intrusion. Sharp and wavy boundary with Context 4.
Munsell: 7.5Y 3/2 (dark brown), pH: 6

Context 5 (B2) 810-1100+mm: Indurated, dry, mottled clay sand. Single grained structure. Well sorted with no obvious stony inclusions. Munsell: 10Y 6/4 (light yellow brown) and 10Y 5/8 (yellow brown), pH: 5.5

Figure 14: Machine Test Pit 9, section drawing (north wall)

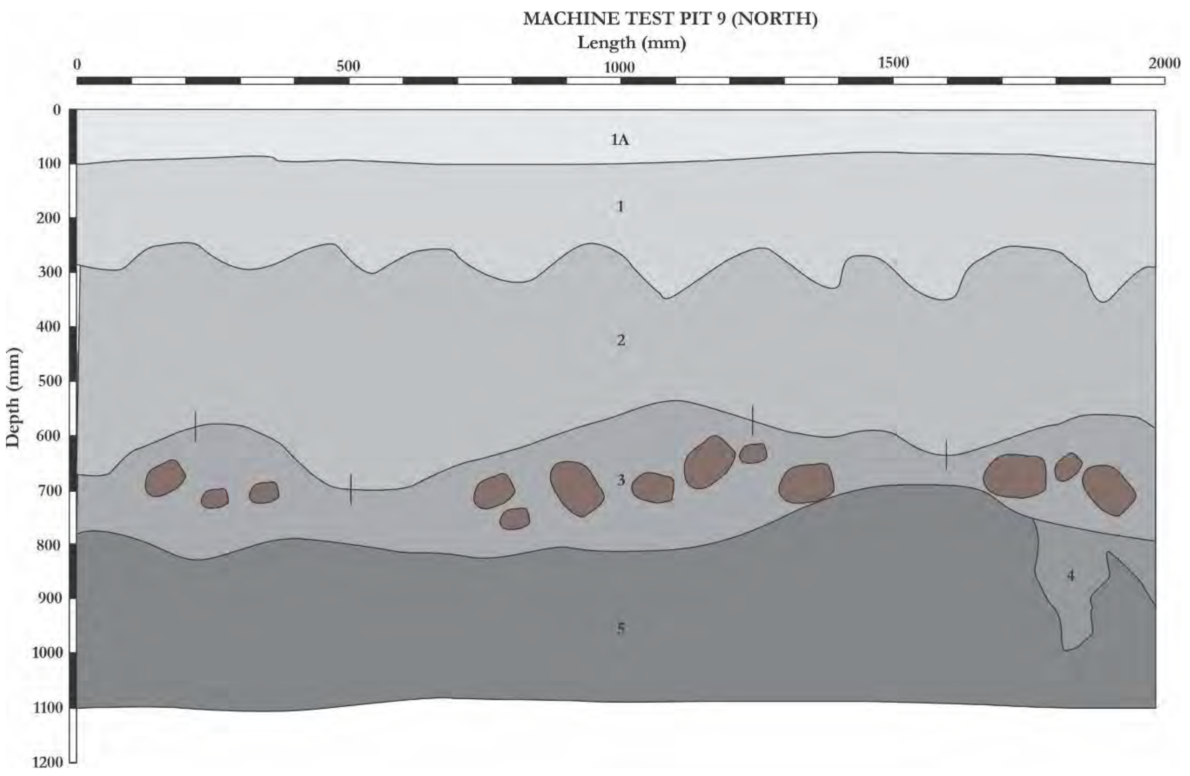


Plate 23: Machine Test Pit 9, north wall, by S Coxe, 21/9/2021

Table 16: Testing summary – Machine Test Pit 10

Machine Test Pit 10			
Dimension	2x1m	**Landform**	Creek line
Depth of Excavation	630mm		
Evidence of Disturbance	None noted		
GDA 94 Coordinates (Zone 55)	381112.852E/ 5765547.805N		
Aboriginal Cultural Heritage	None		
Soil Description			
Context 1 (A1) 0–310mm: Weakly compacted, friable moist silty clay with abundant small roots. Small, angular, blocky structure. Well sorted with no obvious stony inclusions. Smooth and sharp boundary with Context 2. Recent flood deposit overlying truncated basal clay sand. Sharp and smooth boundary with Context 2 and 3. Munsell: 10YR 2/1 (black), pH: 4.5. **Context 2 (B1)** 310–420mm: Loose, wet, friable sand. Single grained structure, poorly sorted, with common inclusions of sub-rounded 'coffee' rock pebbles and cobbles. Diffuse and wavy boundary with Context 3.			

Munsell: 7.5Y 3/2 (dark brown), pH: 6

Context 3 (B2) 310–630+mm: Indurated, dry, and friable, mottled clay sand. Single grained structure. Well sorted with no obvious stony inclusions. Munsell: 10Y 6/4 (light yellow brown) and 10Y 5/8 (yellow brown), pH: 5.5

Figure 15: Machine Test Pit 10, section drawing (north wall)

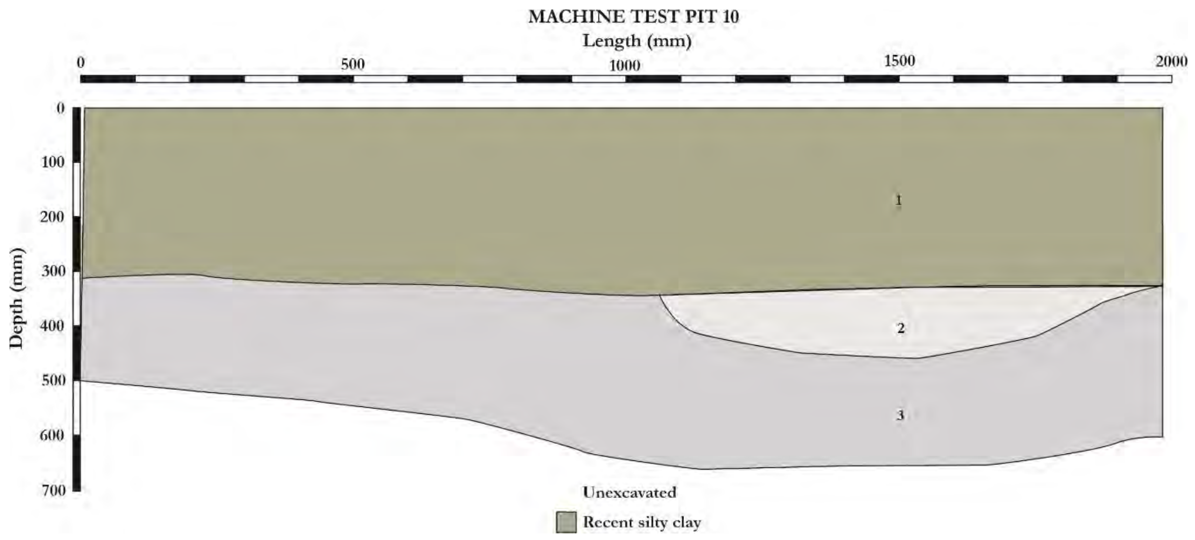


Plate 24: Machine Test Pit 10, north wall, by S Coxe, 21/9/2021

Table 17: Testing summary – Machine Test Pit 11

<table>
<tr><th colspan="4">Machine Test Pit 11</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Creek line</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">730mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">381199.748E/ 765523.706N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><th colspan="4">Soil Description</th></tr>
<tr><td colspan="4">Context 1 (O) 0–100mm: Moderately compacted, wet sandy silt with abundant small roots. Small, sub-angular blocky structure. Moderately sorted with stony inclusions of rare small quartz rounded pebbles; sand at this location is coarser than that observed in MTPs 1–8. Smooth and sharp boundary with Context 2.
Munsell: 10YR 2/2 (very dark brown), pH: 6.5

Context 2 (A1) 100–470mm: Loose and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.</td></tr>
</table>

Munsell: 10YR 2/1 (black), pH: 6.5

Context 3 (A2E)470–610mm: Loose, wet, fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Abrupt and wavy boundary with Context 4.
Munsell: 10YR 5/1(grey), pH: 7.5

Context 4 (B2) 610–730+mm: Firm, wet, mottled sandy clay. Medium angular blocky structure. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 10YR 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 7.5

Figure 16: Machine Test Pit 11, section drawing (north wall)

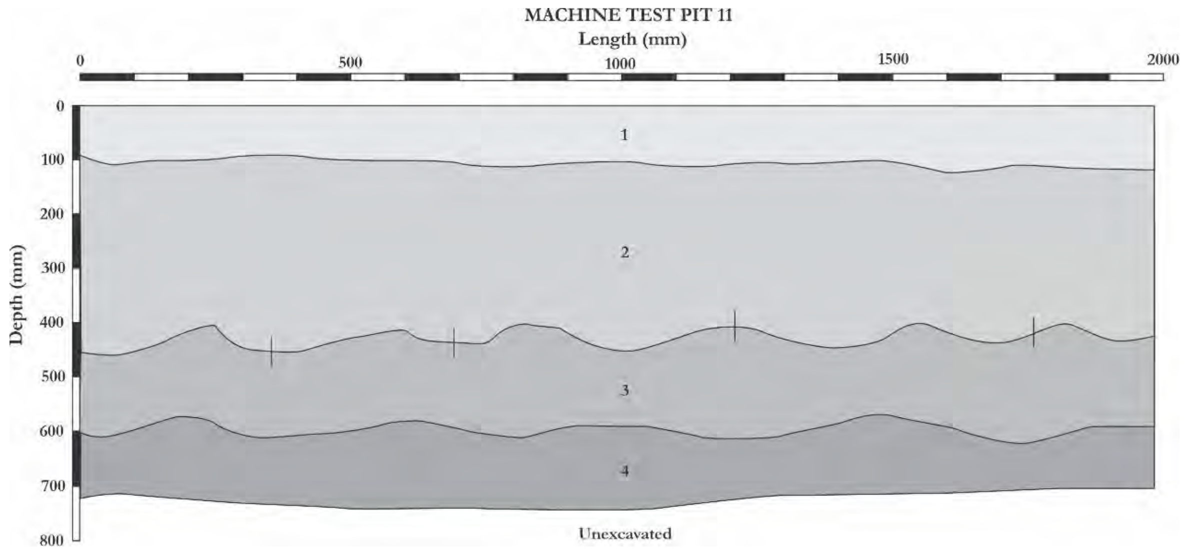


Plate 25: Machine Test Pit 11, north wall, by S Coxe, 15/11/2021

Table 18: Testing summary – Machine Test Pit 12

<table>
<tr><th colspan="4">Machine Test Pit 12</th></tr>
<tr><td>Dimension</td><td>2x1m</td><td>Landform</td><td>Alluvial plain</td></tr>
<tr><td>Depth of Excavation</td><td colspan="3">800mm</td></tr>
<tr><td>Evidence of Disturbance</td><td colspan="3">None noted</td></tr>
<tr><td>GDA 94 Coordinates (Zone 55)</td><td colspan="3">381240.302E/ 5765489.654N</td></tr>
<tr><td>Aboriginal Cultural Heritage</td><td colspan="3">None</td></tr>
<tr><th colspan="4">Soil Description</th></tr>
<tr><td colspan="4">Context 1 (0) 0–100mm: Moderately compacted, wet sandy silt with abundant small roots. Small, sub-angular blocky structure. Moderately sorted with stony inclusions of rare small quartz rounded pebbles; sand at this location is coarser than that observed in MTPs 1–8. Smooth and sharp boundary with Context 2.
Munsell: 10YR 2/2 (very dark brown), pH: 6.5

Context 2 (A1) 100–240mm: Loose, and friable wet loamy sand. Single grained structure. Well sorted with no obvious stony inclusions. Wavy and diffuse boundary with Context 3.</td></tr>
</table>

Munsell: 10YR 2/1 (black), pH: 6.5

Context 3 (A2E) 240–430mm: Loose, wet fine-grained sand. Single grained structure. Well sorted with no obvious stony inclusions. Diffuse and wavy boundary with Context 4.
Munsell: 10YR 5/1(grey), pH: 7.5

Context 4 (B1) 430+mm: Firm, wet, mottled sandy clay. Medium angular blocky structure. Light grey suggests gleying (waterlogged and anaerobic conditions prevalent at this location).
Munsell: 10YR 7/2 (light grey) and 2.5Y 7/8 (yellow), pH: 7.5

Figure 17: Machine Test Pit 12, section drawing (north wall)

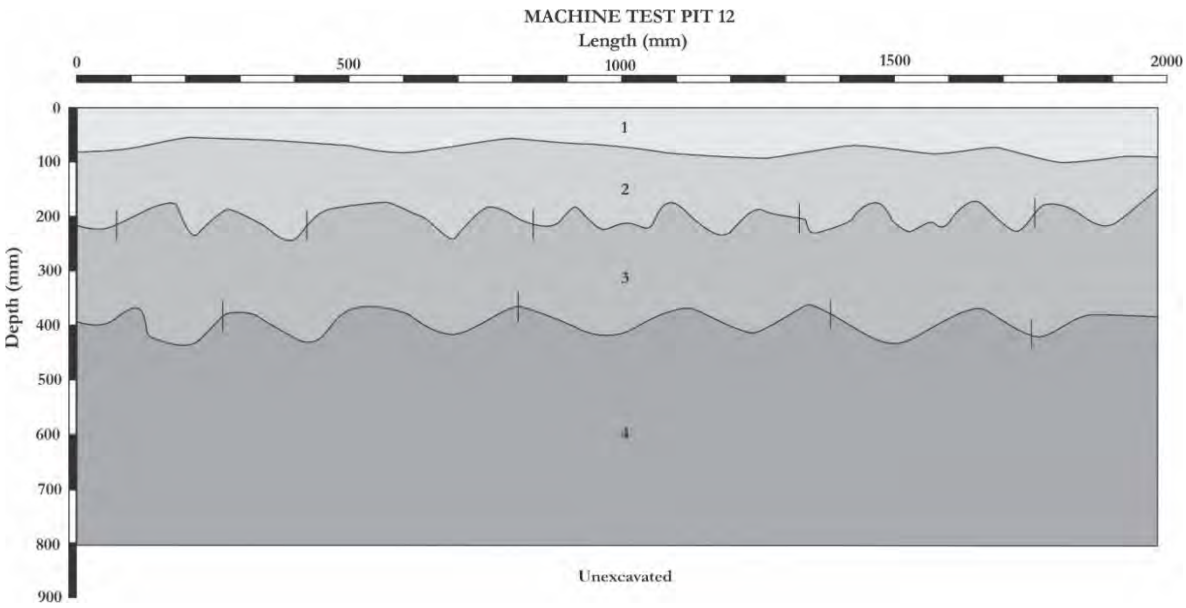


Plate 25: Machine Test Pit 12, north wall, by S Coxe, 15/11/2021

9.3.2 Aboriginal Cultural Heritage

No Aboriginal cultural remains were recovered from the complex assessment.

9.4 Conclusions from the Complex Assessment

The complex assessment investigated all landforms scheduled for impact within the activity area that were likely to contain Aboriginal cultural heritage materials. These areas included the paddocks to the west and east of the main access road into the quarry, mapped predominantly as Alluvium (Qa1) and characterised as an open flood plain, and the area to the immediate north of the modified channel, also predominantly mapped as Alluvium (Qa1).

The soils encountered during the complex assessment were consistent throughout the activity area, with MTPs 9 and 10 exhibiting slightly different soil profiles. MTPs 1–8 recorded moderately and loosely compacted very dark grey sandy loams, greyish-brown and light brownish sands, overlying firmly compacted mottled light grey and yellow clays. MTP 9 recorded loosely compacted and friable black silty sands, grey and dark brown sands, overlying indurated compacted mottled light yellow brown and yellow brown clay sand. The upper part of the soil horizon has been truncated within MTP 10. MTPs 11 and 12 recorded moderately and loosely compacted very dark brown sandy silts, black and grey sands, overlying firmly compacted mottled light grey and yellow clays. MTPs 11 and 12 also show variations in sand grain size when compared to the sands observed in MTPs 1–8.

Evidence of disturbance from the modification of the channel was noted in MTPs 9 and 10.

The desktop assessment suggested that Aboriginal Places are more likely to be present near water courses and that the deep sandy soils formed on the inland dune are more unlikely to have been disturbed to depths where Aboriginal cultural materials are likely to be present. The land-use history determined that the activity area had undergone some ground disturbance in the form of modification of the channel that bisects the activity area (and agricultural activities prior to the advent of sand quarrying), but that significant ground disturbance was unlikely to have irredeemably removed or harmed Aboriginal cultural materials, if present, throughout much of the activity area.

The desktop assessment identified four previously recorded Aboriginal Places (VAHR 8021-0369; VAHR 8021-0370; VAHR 8021-0373; and VAHR 8021-0374) within the activity area and two previously recorded Aboriginal Places within the immediate vicinity of the activity area (VAHR 8021-0371 and VAHR 8021-0372). The standard assessment identified no Aboriginal cultural heritage within the activity area. The results of the complex assessment for CHMP 11342 (Barker and McAlister 2012) demonstrated that subsurface evidence of Aboriginal occupation within the activity area is limited and very localised; a total of 37 artefacts were recovered during testing, with only 11 artefacts recovered from Yannathan AS 6 (VAHR 8021-0374), which was retained and protected. Other areas containing small artefact assemblages were also found on sandy rises within the activity area. It was noted by Barker and McAlister (2012) that much of the sandy rise that constitutes Yannathan AS 6 (VAHR 8021-0374) had previously been destroyed by sand extraction and that the artefacts recovered were likely representative of a much larger site. Thus, the 11 artefacts may be marginal to a more intensively occupied or utilised part of the now greatly diminished Place. Furthermore, during the same program of excavations testing away from sandy rises and along the alluvial flood plain failed to identify Aboriginal cultural materials. These original findings correlate well with the results of the complex assessment for the current CHMP.

It is possible that the proximity of the original drainage line, which would have originally been a broad and shallow low energy channel flowing east-west (paleochannels are visible within the activity area in the 1947 aerial photograph, Figure 2), would have influenced soil formation along its course, perhaps the result of a low levee marking relatively higher ground. The sand at this location (see also MTPs 11 and 12) is coarser than that observed in MTPs 1–8, suggesting a higher energy flow with coarser sands dropping out of suspension as floodwaters moved through the area.

As with MTP 9, the coarseness of the sand grains observed within the upper profiles of MTPs 11–12 differs from MTPs 1–8, being larger in size. However, at lower depths the sand component is much finer, which suggests an increase in flow energy within the upper deposits. It is also suggested that proximity to the original drainage line has influenced the soil formation observed at these two locations. It is highly probable that the area represents a previous zone of frequent but seasonal flooding on marginally higher ground, probably within thickets of swampy riparian woodland (originally quite impenetrable to Europeans prior to draining and clearance of the Koo Wee Rup Swamp and Lang Lang Swamp.

During the complex testing, many of the test locations were found to be saturated after weeks of heavy rainfall. The basal clays showed evidence of gleyification throughout much of the area, which is suggestive of frequent waterlogging and creates anaerobic conditions. In short, the low-lying areas flanking the channel location do not appear to have been suitable for camping by Aboriginal peoples in the past. Conversely, the absence of Aboriginal cultural heritage material in any of the subsurface testing locations (all of which are located in the low-lying areas) suggests that Aboriginal people in the past were more inclined to occupy an area focused on the rise that constitutes VAHR 8021-0374. This location, while being a low relief rise, is notable for its commanding position in an otherwise low-lying landscape prone to inundation.

10.0 Aboriginal Cultural Heritage Within the Activity Area

Although no Aboriginal cultural heritage was located during preparation of this CHMP, Aboriginal cultural heritage is located within the current activity area as a result of works undertaken for CHMP 11342. The cultural heritage has been registered as VAHR 8021-0369; VAHR 8021-0370; VAHR 8021-0373; and VAHR 8021-0374. These Places contain a total of 25 recorded artefacts, consisting of 24 artefacts recovered during subsurface testing and 1 artefact located in a surface context (See Appendix 6).

The following information in relation to Aboriginal cultural heritage within the activity area has been taken from approved CHMP 11342.

10.1 VAHR 8021-0369

VAHR Number: 8021-0369

Field Name: Yannathan IA 1

Primary Grid Coordinate GDA 94:
380501E 5765502N (Zone 55)

Cadastral details:
100B, PP2969, 870
Westernport Road, Yannathan,
Parish of Lang Lang East,
Shire of Cardinia.

Description of Aboriginal Place VAHR 8021-0369

Site VAHR 8021-0369 (Yannathan IA 1) comprised 1 silcrete stone artefact which was located on the surface near a well in a paddock used for horse grazing (Plate 25). To establish the extent of the site and to determine if the site had a sub-surface component, Test Pit 4 was excavated directly underneath where the surface artefact was located.

The excavation of TP4 underneath the location of the artefact revealed that this site has no sub-surface component. It is assumed that past vegetation clearance, the construction of a nearby well and stock grazing will have disturbed the upper soil layers and as the TP only reached a depth of 250mm, sub-surface deposits are very shallow.

The artefact is not considered to be *in situ*.

Conclusion

The Aboriginal Place potentially represents the remnants of a much larger occupation site that was situated on the sandy rise that existed prior to the excavation of Hanson Quarry. The site is located on the fringes of the excavated quarry, and may represent the edge of a larger occupation site.

The site possibly represents the remains of an Aboriginal campsite or sites that were occupied prior to the arrival of Europeans. The small quantity of stone artefacts suggest that the site was a short-term site located to utilise the resources of the adjacent watercourses and swamps. Lang Lang River is located over 2km away however a small unnamed watercourse intersects with the activity area.

The Aboriginal Place 8021-0369 is shown below in Plate 25. Samples of artefacts from VAHR 8021-0369 are shown below in Plate 26. The Place extent is presented in Figure 18.

Plate 25: VAHR 8021-0369: Photograph of site location (photo by Renee McAlister 29/3/2012)

Plate 26: Photograph of Artefact from VAHR 8021-0369 (S. Brown 29/3/2012)

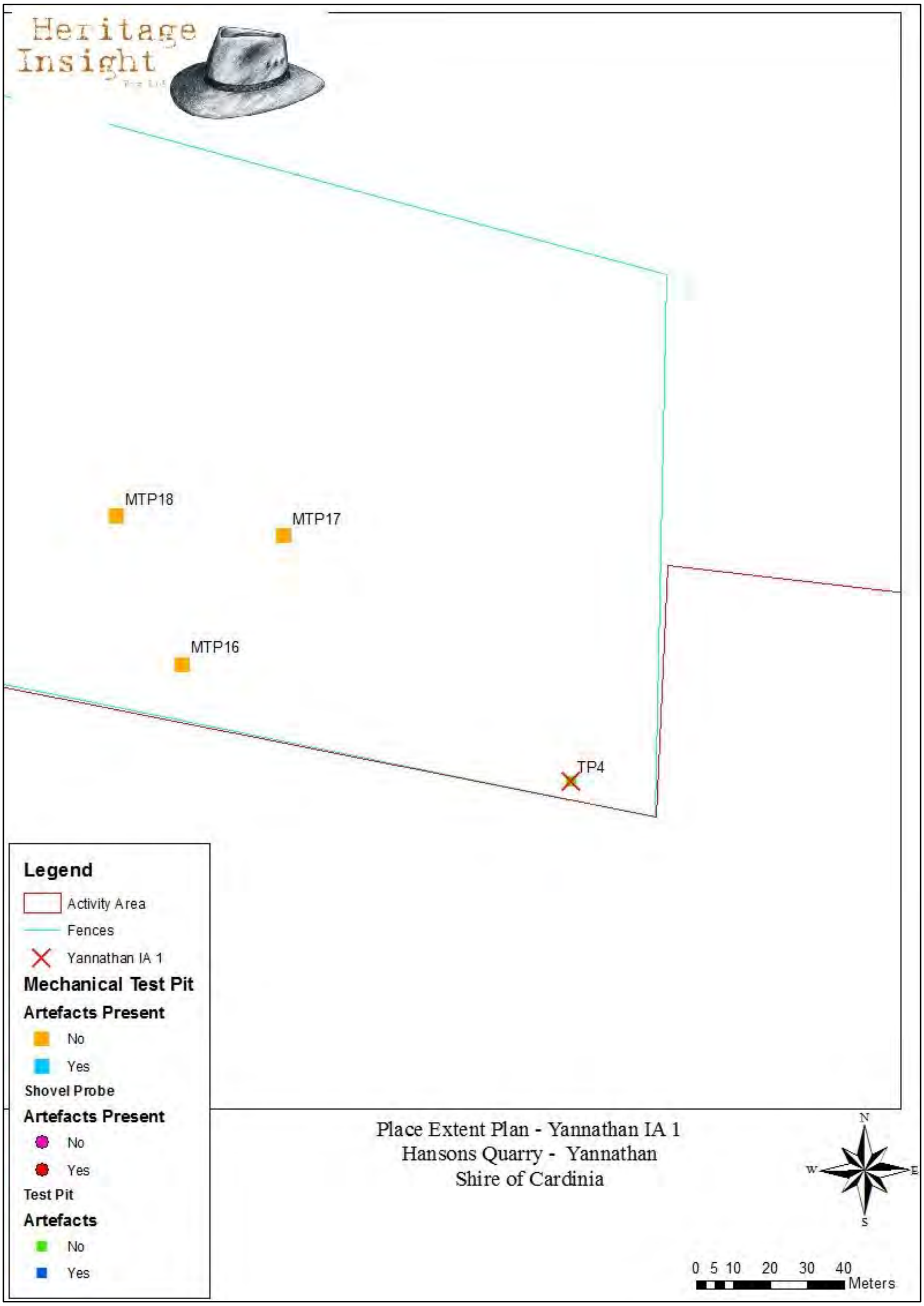


Figure 18: Place Extent Plan - VAHR 8021-0369 Yannathan IA 1

Aboriginal Place Significance Assessment

The significance of the Aboriginal archaeological heritage located during works for this CHMP has been assessed against the Australia ICOMOS Burra Charter Criteria for the assessment of cultural significance (Australia ICOMOS Incorporated 2013).

In the Burra Charter, 'cultural significance' is defined as "...aesthetic, historic, scientific, social or spiritual value for past, present or future generations" (Australia ICOMOS Incorporated 2013 Article 1.2). Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of meanings for individuals or groups. The Burra Charter also states that "Cultural significance may change over time and with use. Understanding of cultural significance may change as a result of new information" (Australia ICOMOS Incorporated 2013, p.2 Explanatory note).

Although the Burra Charter is more applicable to non-Aboriginal sites and structures, it may be adapted to assess Aboriginal heritage significance. In particular, the views of contemporary Aboriginal people must be taken into consideration when assessing the following values.

The Burra Charter definitions and ratings used within the following assessment are provided in Appendix 3.

Assessment of Significance – VAHR 8021-0369

Aesthetic Value

The Aboriginal Places recorded have some aesthetic value. This is largely because although the vegetation has significantly altered due to land clearance, the overall landscape context of the area is similar to that of the past. In keeping with the Burra Charter's principle that "...cultural significance may change as a result of the continuing history of the place..." it may be possible to enhance the aesthetic values of some sites, by sympathetic landscape treatment in future.

Historic Value

All Aboriginal Places can be considered to be of value to the history of the local region generally and to descendants of Traditional Aboriginal Owners in particular. All archaeological sites illustrate aspects of the past use of the landscape by Aboriginal people and all sites have the potential to provide information on changes in Aboriginal economic and technological practices in the local area prior to the arrival of Europeans. Additionally, the presence of artefacts manufactured from glass indicates that post-contact occupation occurred within the activity area. The preceding millennia and high frequency of stone artefacts recovered during testing underscores the adaptive nature of Aboriginal peoples and the adoption of new materials in the face of dramatic social upheaval that was to change landscape and its people forever.

Scientific Value

VAHR 8021-0369 has been assessed as having low archaeological significance overall. This site is considered to be of low cultural heritage significance due to the low number of artefacts present, common occurrence of this site type in the area and no evidence of any intact sub surface deposits.

Table 19: Scientific significance assessment of VAHR 8021-0369

	Site Contents	Site Condition	Representativeness	Overall Archaeological Significance
VAHR 8021-0369	1	1	1	3 (low)

Social Value

Many Aboriginal people regard archaeological sites as holding considerable social and cultural value, irrespective of their scientific significance. This arises not only from the material remains that represent a connection to their ancestors, but also from beliefs in the association of archaeological sites and land or 'Country'. Protection of archaeological sites and remnant sections of landscape form part of their traditional obligations to looking after 'Country', which were handed down to them by their ancestors. VAHR 8021-0369 is likely to be regarded as being of high social and cultural value to the Traditional Owners.

Spiritual Value

There has been no indication expressed by the Traditional Owners to date of any spiritual values attached to the site. However, it is recognised that all Aboriginal cultural heritage represents a spiritual connection with the land.

Statement of Significance

Comment on the cultural values and significance of Aboriginal Places can only be made by the Aboriginal community.

The following general statement of significance has been provided by the Bunurong Land Council Aboriginal Corporation:

> Over the last 35,000 years Bunurong people have adapted to a range of significant changes within their Country. Our stories of the Bay flooding with water, asteroid impacts near Cranbourne, Arthurs Seat once being an Island, volcanic activity in the western suburbs, the great floods, fires and earthquakes, all speak of such events.
>
> Over 1000 generations of our people have been here before us. Archaeological excavation within our Country has already demonstrated about 35,000 year's worth of occupation. These sites can show us how our ancestors interacted with their environment and how that interaction changed over time. We regard all evidence of our people's occupation as sacred.
>
> No amount of data can compensate for the loss of a site but if we can't literally preserve a site, the only other way it may be preserved is by way of careful data collection as part of a Cultural Heritage Management Plan (CHMP). The importance of the accuracy of this data being collected for protection is paramount as we regard this information as sacred. It holds the stories of our people and our past. In some places our archaeology is the only thing that remains within a given landscape, the only thing left that hasn't been changed or moved, and because of this, it is now sacred to us.

All of our Country is highly significant, every square inch, every rock, every leaf, every dune, every artefact. If we could attribute the cause of this blanket high significance rating of our Country to any one thing, it would be that in Melbourne especially, so much has been destroyed and lost as the city grew, and so quickly. If you lose enough of something, what little you have left becomes so much more important. Similarly, when someone passes, their earthly possessions become more important to those they left behind.

With regards to knowledge and stories, each of our Elders that passed away during early colonisation is the equivalent of a state library burning down today. One Bunurong Elder of the time was famously quoted saying that, 'Once we are gone, no one is going to know where anything is'. Clearly considering the vast amount of knowledge he and his people had collected about the landscape, all written in their songs and stories. Another Elder was noted as saying, 'one day smart people will lament at our passing', no doubt acknowledging again the ocean of information collected on every living thing here, every tree, every animal and the key to the complex balance of all things that his people had managed to evolve and sustain. European people are still learning of the complexities of Aboriginal culture.

With no written language and change occurring here so quickly, we have lost many of the ancient stories of this landscape. At the time, Bunurong people's focus was more on trying to stay alive than the luxuries of continuing to practice culture, which included the careful passing on of stories and knowledge, different levels of which would require certain initiations, performed over time.

10.2 VAHR 8021-0370

VAHR Number: 8021-0370

Field Name: Yannathan IA 2

Primary Grid Coordinate GDA 94:
380309E 5765548N (Zone 55)

Cadastral details:
100B, PP2969, 870
Westernport Road, Yannathan,
Parish of Lang Lang East,
Shire of Cardinia.

Description of Aboriginal Place VAHR 8021-0370

Site VAHR 8021-0370 (Yannathan IA 2) is comprised of one silcrete artefact located within Mechanical Test Pit 14. To establish the extent of the site a test pit (TP5) and a series of shovel test pits (STP12-17) were excavated at 5m intervals radiating out north, east, south and west around Mechanical Test Pit 14. The soil stratigraphy of the shovel test pits was consistent with that found in Mechanical Test Pit 14 and Test Pit 5.

As the site comprises an isolated artefact, the site extent is a single point.

No visible evidence of disturbance was noted in the soil profile; however, it is assumed that the impact of past vegetation clearance and stock grazing will have disturbed the upper 300mm.

Therefore, it is considered that the artefacts below 300mm are undisturbed and *in-situ*.

Conclusion

The Aboriginal Place potentially represents the remnants of a much larger occupation site that was situated on the sandy rise that existed prior to the excavation of Hanson Quarry. The site is located on the fringes of the excavated quarry, and may represent the edge of a larger occupation site.

The site possibly represents the remains of an Aboriginal campsite or sites that were occupied prior to the arrival of Europeans. The small quantity of stone artefacts suggest that the site was a short-term site located to utilise the resources of the adjacent watercourses and swamps. Lang Lang River is located over 2km away however a small unnamed watercourse intersects with the activity area.

The Aboriginal Place 8021-0370 is shown below in Plate 27. Samples of artefacts from VAHR 8021-0370 are shown below in Plate 28. The Place and components extents are presented in Figure 19.

Plate 27: VAHR 8021-0370: Photograph of site location (photo by Renee McAlister 29/3/2012)

Plate 28: Photograph of Artefact from VAHR 8021-0370 (S. Brown 29/3/2012)

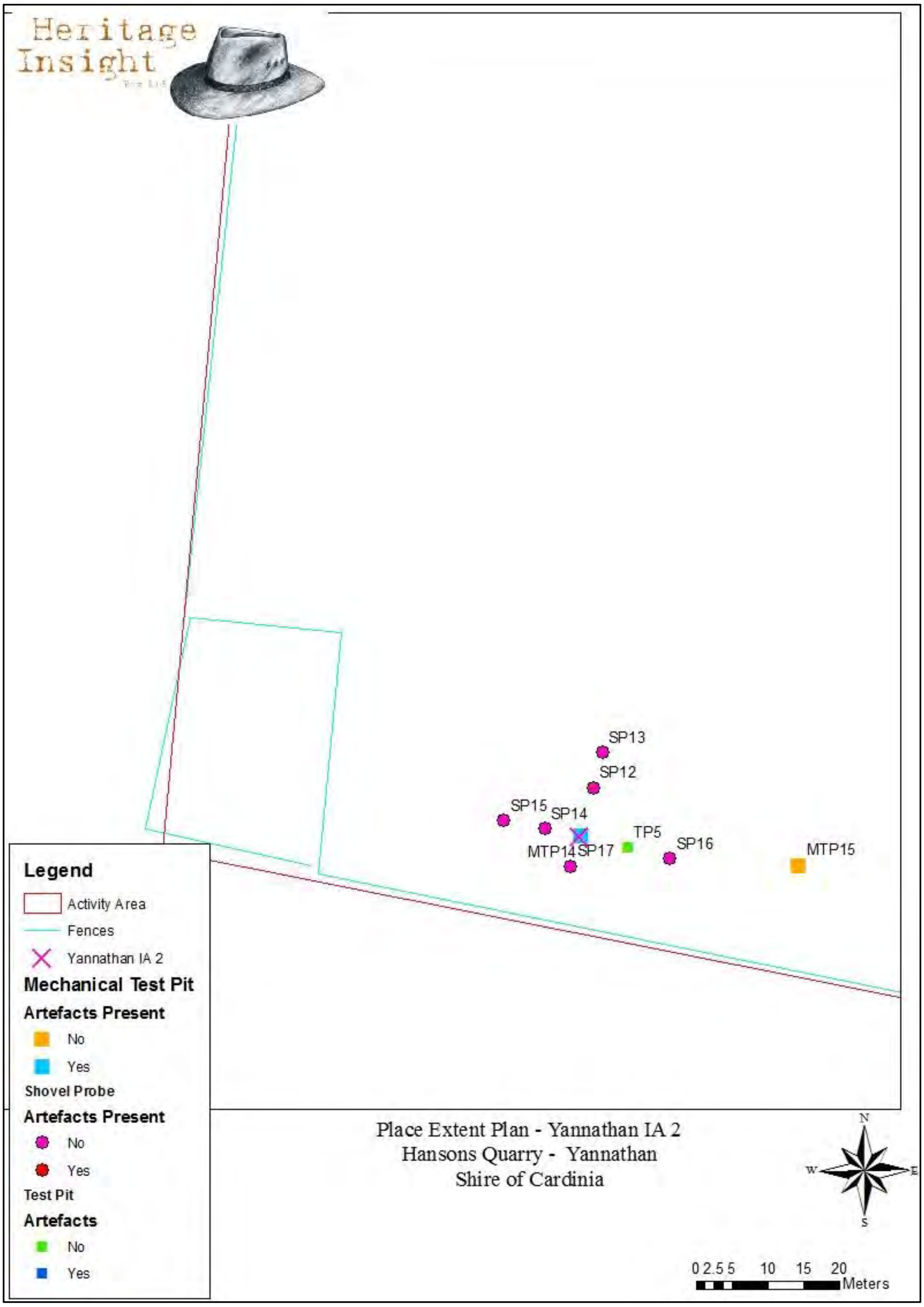


Figure 19: Place Extent Plan - VAHR 8021-0370 Yannathan IA 2

Aboriginal Place Significance Assessment

The significance of the Aboriginal archaeological heritage located during works for this CHMP has been assessed against the Australia ICOMOS Burra Charter Criteria for the assessment of cultural significance (Australia ICOMOS Incorporated 2013).

In the Burra Charter, 'cultural significance' is defined as "...aesthetic, historic, scientific, social or spiritual value for past, present or future generations" (Australia ICOMOS Incorporated 2013 Article 1.2). Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of meanings for individuals or groups. The Burra Charter also states that "Cultural significance may change over time and with use. Understanding of cultural significance may change as a result of new information" (Australia ICOMOS Incorporated 2013, p.2 Explanatory note).

Although the Burra Charter is more applicable to non-Aboriginal sites and structures, it may be adapted to assess Aboriginal heritage significance. In particular, the views of contemporary Aboriginal people must be taken into consideration when assessing the following values.

The Burra Charter definitions and ratings used within the following assessment are provided in Appendix 3.

Assessment of Significance – VAHR 8021-0370

Aesthetic Value

The Aboriginal Places recorded have some aesthetic value. This is largely because although the vegetation has significantly altered due to land clearance, the overall landscape context of the area is similar to that of the past. In keeping with the Burra Charter's principle that "...cultural significance may change as a result of the continuing history of the place..." it may be possible to enhance the aesthetic values of some sites, by sympathetic landscape treatment in future.

Historic Value

All Aboriginal Places can be considered to be of value to the history of the local region generally and to descendants of Traditional Aboriginal Owners in particular. All archaeological sites illustrate aspects of the past use of the landscape by Aboriginal people and all sites have the potential to provide information on changes in Aboriginal economic and technological practices in the local area prior to the arrival of Europeans. Additionally, the presence of artefacts manufactured from glass indicates that post-contact occupation occurred within the activity area. The preceding millennia and high frequency of stone artefacts recovered during testing underscores the adaptive nature of Aboriginal peoples and the adoption of new materials in the face of dramatic social upheaval that was to change landscape and its people forever.

Scientific Value

VAHR 8021-0370 has been assessed as having low archaeological significance overall. This site is considered to be of low cultural heritage significance due to the low number of artefacts present, common occurrence of this site type in the area and no evidence of any intact sub surface deposits.

Table 20: Scientific significance assessment of VAHR 8021-0370

	Site Contents	Site Condition	Representativeness	Overall Archaeological Significance
VAHR 8021-0370	1	1	1	3 (low)

Social Value

Many Aboriginal people regard archaeological sites as holding considerable social and cultural value, irrespective of their scientific significance. This arises not only from the material remains that represent a connection to their ancestors, but also from beliefs in the association of archaeological sites and land or 'Country'. Protection of archaeological sites and remnant sections of landscape form part of their traditional obligations to looking after 'Country', which were handed down to them by their ancestors. VAHR 8021-0370 is likely to be regarded as being of high social and cultural value to the Traditional Owners.

Spiritual Value

There has been no indication expressed by the Traditional Owners to date of any spiritual values attached to the site. However, it is recognised that all Aboriginal cultural heritage represents a spiritual connection with the land.

Statement of Significance

Comment on the cultural values and significance of Aboriginal Places can only be made by the Aboriginal community.

The following general statement of significance has been provided by the Bunurong Land Council Aboriginal Corporation:

> Over the last 35,000 years Bunurong people have adapted to a range of significant changes within their Country. Our stories of the Bay flooding with water, asteroid impacts near Cranbourne, Arthurs Seat once being an Island, volcanic activity in the western suburbs, the great floods, fires and earthquakes, all speak of such events.
>
> Over 1000 generations of our people have been here before us. Archaeological excavation within our Country has already demonstrated about 35,000 year's worth of occupation. These sites can show us how our ancestors interacted with their environment and how that interaction changed over time. We regard all evidence of our people's occupation as sacred.
>
> No amount of data can compensate for the loss of a site but if we can't literally preserve a site, the only other way it may be preserved is by way of careful data collection as part of a Cultural Heritage Management Plan (CHMP). The importance of the accuracy of this data being collected for protection is paramount as we regard this information as sacred. It holds the stories of our people and our past. In some places our archaeology is the only thing that remains within a given landscape, the only thing left that hasn't been changed or moved, and because of this, it is now sacred to us.
>
> All of our Country is highly significant, every square inch, every rock, every leaf, every dune, every artefact. If we could attribute the cause of this blanket high significance rating of our Country to any one thing, it would be that in Melbourne especially, so much has been destroyed and lost as the city grew, and so quickly. If you lose enough of something, what little

you have left becomes so much more important. Similarly, when someone passes, their earthly possessions become more important to those they left behind.

With regards to knowledge and stories, each of our Elders that passed away during early colonisation is the equivalent of a state library burning down today. One Bunurong Elder of the time was famously quoted saying that, 'Once we are gone, no one is going to know where anything is'. Clearly considering the vast amount of knowledge he and his people had collected about the landscape, all written in their songs and stories. Another Elder was noted as saying, 'one day smart people will lament at our passing', no doubt acknowledging again the ocean of information collected on every living thing here, every tree, every animal and the key to the complex balance of all things that his people had managed to evolve and sustain. European people are still learning of the complexities of Aboriginal culture.

With no written language and change occurring here so quickly, we have lost many of the ancient stories of this landscape. At the time, Bunurong people's focus was more on trying to stay alive than the luxuries of continuing to practice culture, which included the careful passing on of stories and knowledge, different levels of which would require certain initiations, performed over time.

10.3 VAHR 8021-0373

VAHR Number: 8021-0373

Field Name: Yannathan AS 5

Primary Grid Coordinate GDA 94:
3801009E 57655471N (Zone 55)

Cadastral details:
100B, PP2969, 870
Westernport Road, Yannathan,
Parish of Lang Lang East,
Shire of Cardinia.

Description of Aboriginal Place VAHR 8021-0373

Site VAHR 8021-0373 (Yannathan AS 5) is comprised of eleven silcrete, quartzite and milky quartz artefacts. Nine artefacts were located within MTP 6, one artefact was located within MTP 22 and one artefact was located within MTP 7. To establish the extent of the site and the nature of the sub-surface stratigraphy a test pit (TP6) and a series of shovel test pits were excavated at 5m intervals radiating north, south and east to determine the site extent. Radial testing did not take place to the west of the site as this area was full of fill dumped from the sand quarry. The information that this area contained fill came from the client and excavation of MTP 26 confirmed this.

MTP 6, 7 and 22 are located on the top of a sandy rise. This sandy rise has been disturbed to the south where a levee bank has been constructed. To the north and west the sandy rise slopes downward and becomes open plain.

The extent of this site is 656m^2 and is considered to be the undisturbed section of the sandy rise.

The artefacts retrieved from MTP 6 comprise complete flakes, broken flakes and angular fragments. MTP 22 contained a complete flake. MTP 7 contained a silcrete core, indicating that stone tool manufacturing was taking place in this area. The low number of artefacts prevents a more detailed analysis of the site.

It is considered that this site is probably located on the fringe of what was originally a larger site including the area to the south-west which has since been quarried away. As all the sites located within the Activity Area are focused around the area that has been quarried and will be the edges of a larger sandy rise which would have been the first section targeted for quarrying. This site would have been a larger occupation site. What we have located is most likely the remaining fragments of a larger site.

Conclusion

The Aboriginal Place potentially represents the remnants of a much larger occupation site that was situated on the sandy rise that existed prior to the excavation of Hanson Quarry. The site is located on the fringes of the excavated quarry, and may represent the edge of a larger occupation site.

The site possibly represents the remains of an Aboriginal campsite or sites that were occupied prior to the arrival of Europeans. The small quantity of stone artefacts suggest that the site was a short-term site located to utilise the resources of the adjacent watercourses and swamps. Lang Lang River is located over 2km away however a small unnamed watercourse intersects with the activity area.

The Aboriginal Place 8021-0373 is shown below in Plate 29. Samples of artefacts from VAHR 8021-0373 are shown below in Plate 30. The Place and components extents are presented in Figure 20.

Plate 29: VAHR 8021-0373: Photograph of site location (photo by Renee McAlister 29/3/2012)

Plate 30: Photograph of Artefact from VAHR 8021-0373 (S. Brown 29/3/2012)

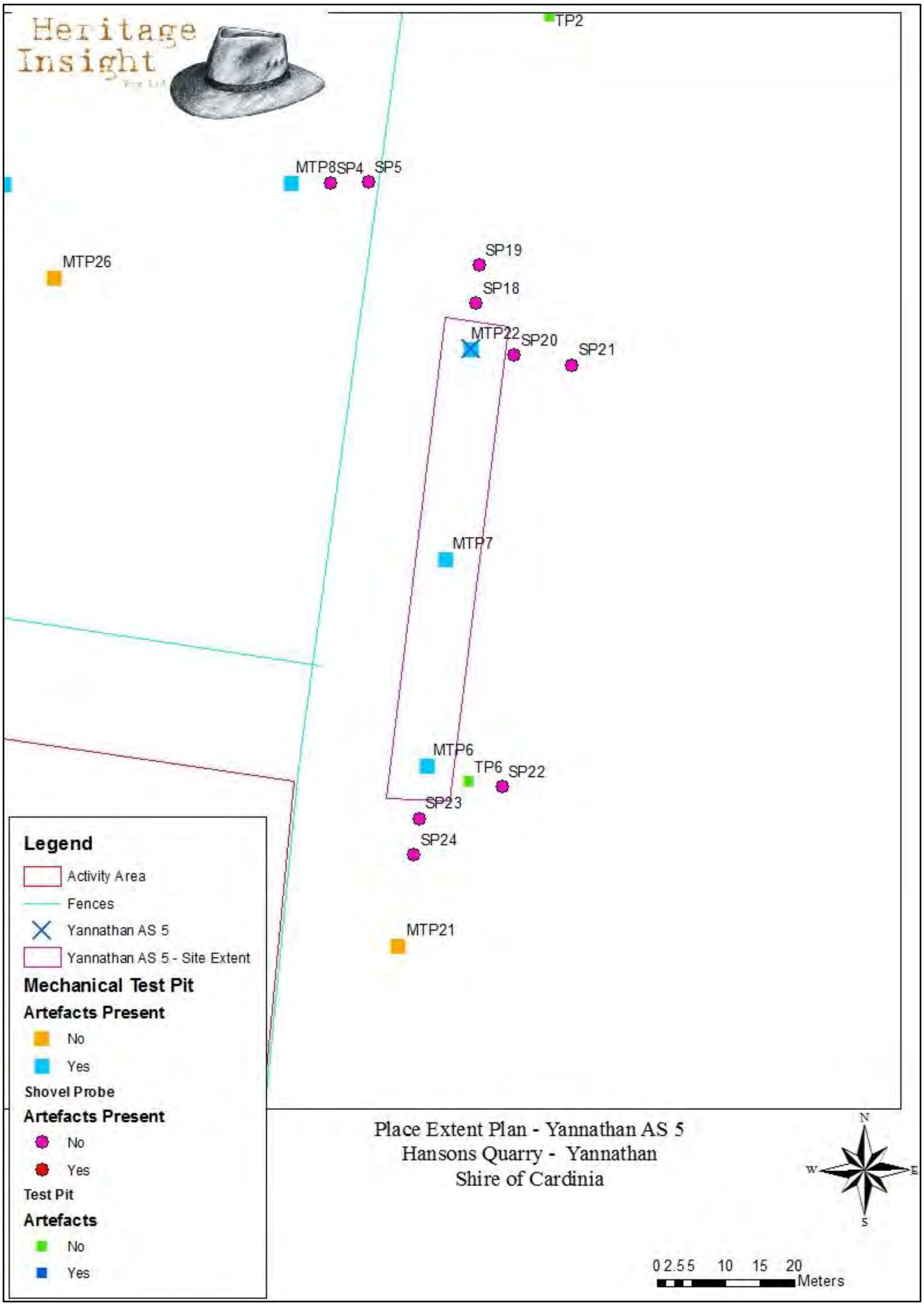


Figure 20: Place Extent Plan - VAHR 8021-0373 Yannathan AS 5

Aboriginal Place Significance Assessment

The significance of the Aboriginal archaeological heritage located during works for this CHMP has been assessed against the Australia ICOMOS Burra Charter Criteria for the assessment of cultural significance (Australia ICOMOS Incorporated 2013).

In the Burra Charter, 'cultural significance' is defined as "...aesthetic, historic, scientific, social or spiritual value for past, present or future generations" (Australia ICOMOS Incorporated 2013 Article 1.2). Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of meanings for individuals or groups. The Burra Charter also states that "Cultural significance may change over time and with use. Understanding of cultural significance may change as a result of new information" (Australia ICOMOS Incorporated 2013, p.2 Explanatory note).

Although the Burra Charter is more applicable to non-Aboriginal sites and structures, it may be adapted to assess Aboriginal heritage significance. In particular, the views of contemporary Aboriginal people must be taken into consideration when assessing the following values.

The Burra Charter definitions and ratings used within the following assessment are provided in Appendix 3.

Assessment of Significance – VAHR 8021-0373

Aesthetic Value

The Aboriginal Places recorded have some aesthetic value. This is largely because although the vegetation has significantly altered due to land clearance, the overall landscape context of the area is similar to that of the past. In keeping with the Burra Charter's principle that "..cultural significance may change as a result of the continuing history of the place.." it may be possible to enhance the aesthetic values of some sites, by sympathetic landscape treatment in future.

Historic Value

All Aboriginal Places can be considered to be of value to the history of the local region generally and to descendants of Traditional Aboriginal Owners in particular. All archaeological sites illustrate aspects of the past use of the landscape by Aboriginal people and all sites have the potential to provide information on changes in Aboriginal economic and technological practices in the local area prior to the arrival of Europeans. Additionally, the presence of artefacts manufactured from glass indicates that post-contact occupation occurred within the activity area. The preceding millennia and high frequency of stone artefacts recovered during testing underscores the adaptive nature of Aboriginal peoples and the adoption of new materials in the face of dramatic social upheaval that was to change landscape and its people forever.

Scientific Value

VAHR 8021-0373 has been assessed as having moderate archaeological significance overall. This site is considered to be of moderate cultural heritage significance due to the low number of artefacts present, common occurrence of this site type in the area, and some evidence of intact sub surface deposits.

Table 21: Scientific significance assessment of VAHR 8021-0373

	Site Contents	Site Condition	Representativeness	Overall Archaeological Significance
VAHR 8021-0373	2	2	1	5 (moderate)

Social Value

Many Aboriginal people regard archaeological sites as holding considerable social and cultural value, irrespective of their scientific significance. This arises not only from the material remains that represent a connection to their ancestors, but also from beliefs in the association of archaeological sites and land or 'Country'. Protection of archaeological sites and remnant sections of landscape form part of their traditional obligations to looking after 'Country', which were handed down to them by their ancestors. VAHR 8021-0373 is likely to be regarded as being of high social and cultural value to the Traditional Owners.

Spiritual Value

There has been no indication expressed by the Traditional Owners to date of any spiritual values attached to the site. However, it is recognised that all Aboriginal cultural heritage represents a spiritual connection with the land.

Statement of Significance

Comment on the cultural values and significance of Aboriginal Places can only be made by the Aboriginal community.

The following general statement of significance has been provided by the Bunurong Land Council Aboriginal Corporation:

> Over the last 35,000 years Bunurong people have adapted to a range of significant changes within their Country. Our stories of the Bay flooding with water, asteroid impacts near Cranbourne, Arthurs Seat once being an Island, volcanic activity in the western suburbs, the great floods, fires and earthquakes, all speak of such events.
>
> Over 1000 generations of our people have been here before us. Archaeological excavation within our Country has already demonstrated about 35,000 year's worth of occupation. These sites can show us how our ancestors interacted with their environment and how that interaction changed over time. We regard all evidence of our people's occupation as sacred.
>
> No amount of data can compensate for the loss of a site but if we can't literally preserve a site, the only other way it may be preserved is by way of careful data collection as part of a Cultural Heritage Management Plan (CHMP). The importance of the accuracy of this data being collected for protection is paramount as we regard this information as sacred. It holds the stories of our people and our past. In some places our archaeology is the only thing that remains within a given landscape, the only thing left that hasn't been changed or moved, and because of this, it is now sacred to us.
>
> All of our Country is highly significant, every square inch, every rock, every leaf, every dune, every artefact. If we could attribute the cause of this blanket high significance rating of our

Country to any one thing, it would be that in Melbourne especially, so much has been destroyed and lost as the city grew, and so quickly. If you lose enough of something, what little you have left becomes so much more important. Similarly, when someone passes, their earthly possessions become more important to those they left behind.

With regards to knowledge and stories, each of our Elders that passed away during early colonisation is the equivalent of a state library burning down today. One Bunurong Elder of the time was famously quoted saying that, 'Once we are gone, no one is going to know where anything is'. Clearly considering the vast amount of knowledge he and his people had collected about the landscape, all written in their songs and stories. Another Elder was noted as saying, 'one day smart people will lament at our passing', no doubt acknowledging again the ocean of information collected on every living thing here, every tree, every animal and the key to the complex balance of all things that his people had managed to evolve and sustain. European people are still learning of the complexities of Aboriginal culture.

With no written language and change occurring here so quickly, we have lost many of the ancient stories of this landscape. At the time, Bunurong people's focus was more on trying to stay alive than the luxuries of continuing to practice culture, which included the careful passing on of stories and knowledge, different levels of which would require certain initiations, performed over time.

10.4 VAHR 8021-0374

VAHR Number: 8021-0374

Field Name: Yannathan AS 6

Primary Grid Coordinate GDA 94:
380967E 5765515N (Zone 55)

Cadastral details:
100B, PP2969, 870
Westernport Road, Yannathan,
Parish of Lang Lang East,
Shire of Cardinia.

Description of Aboriginal Place VAHR 8021-0373

Site VAHR 8021-0374 (Yannathan AS 6) is comprised of nine silcrete flakes, one milky quartz flake, one chert flake and a quartzite flake. Artefact types are broken flakes, angular fragments and complete flakes.

Six artefacts were retrieved from MTP10 at a depth of 300-500mm, two artefacts were retrieved from MTP 8 at a depth of 200-300mm, one artefact was retrieved from MTP 9 at a depth of 400-500mm, one artefact was retrieved from MTP24 at a depth of 300-400mm and two artefacts were retrieved from STP6 at a depth of 500-600mm. The depth of the artefacts represents the relatively shallow depth of the sandy deposits as most artefacts were located just above the coffee rock layer. The low number of artefacts prevents a more detailed analysis.

It is considered that this site is probably located on the fringe of what was originally a larger site, and included the area to the south-west which has since been quarried away. As all the sites located within the Activity Area are focused around the area that has been quarried the current sandy rises will be the edges of a larger sandy rise which would have been the first section targeted for quarrying. This site would have been an occupation site, and what has been located is most likely the remaining fragments of a larger site.

Conclusion

The Aboriginal Place potentially represents the remnants of a much larger occupation site that was situated on the sandy rise that existed prior to the excavation of Hanson Quarry. The site is located on the fringes of the excavated quarry, and may represent the edge of a larger occupation site.

The site possibly represents the remains of an Aboriginal campsite or sites that were occupied prior to the arrival of Europeans. The small quantity of stone artefacts suggest that the site was a short-term site located to utilise the resources of the adjacent watercourses and swamps. Lang Lang River is located over 2km away however a small unnamed watercourse intersects with the activity area.

The Aboriginal Place 8021-0374 is shown below in Plate 31. Samples of artefacts from VAHR 8021-0374 are shown below in Plate 32. The Place and components extents are presented in Figure 21.

Plate 31: VAHR 8021-0374: Photograph of site location (photo by Renee McAlister 29/3/2012)

Plate 32: Photograph of Artefact from VAHR 8021-0374 (S. Brown 29/3/2012)

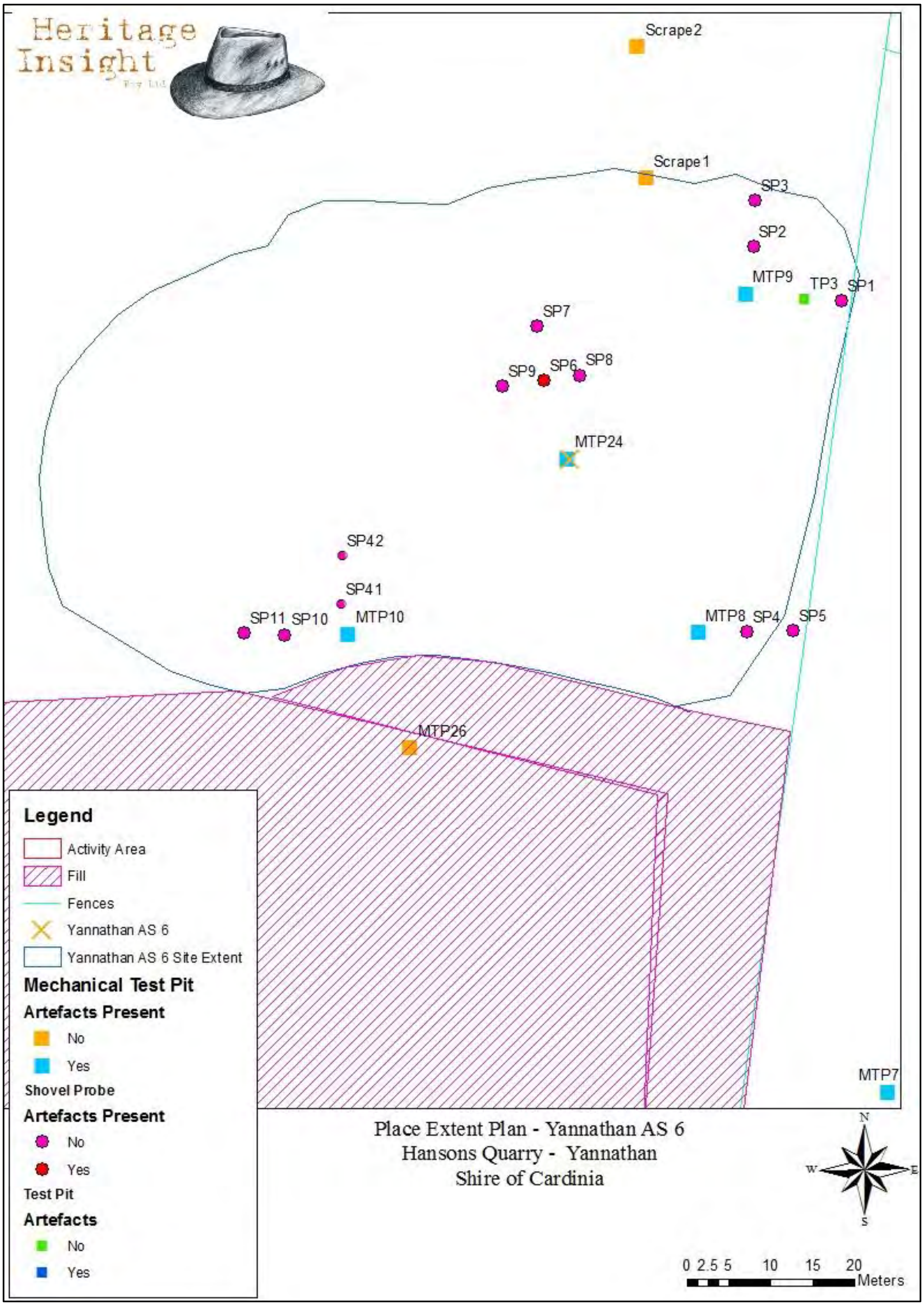


Figure 21: Place Extent Plan - VAHR 8021-0374 Yannathan AS 6

Aboriginal Place Significance Assessment

The significance of the Aboriginal archaeological heritage located during works for this CHMP has been assessed against the Australia ICOMOS Burra Charter Criteria for the assessment of cultural significance (Australia ICOMOS Incorporated 2013).

In the Burra Charter, 'cultural significance' is defined as "...aesthetic, historic, scientific, social or spiritual value for past, present or future generations" (Australia ICOMOS Incorporated 2013 Article 1.2). Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects. Places may have a range of meanings for individuals or groups. The Burra Charter also states that "Cultural significance may change over time and with use. Understanding of cultural significance may change as a result of new information" (Australia ICOMOS Incorporated 2013, p.2 Explanatory note).

Although the Burra Charter is more applicable to non-Aboriginal sites and structures, it may be adapted to assess Aboriginal heritage significance. In particular, the views of contemporary Aboriginal people must be taken into consideration when assessing the following values.

The Burra Charter definitions and ratings used within the following assessment are provided in Appendix 3.

Assessment of Significance – VAHR 8021-0374

Aesthetic Value

The Aboriginal Places recorded have some aesthetic value. This is largely because although the vegetation has significantly altered due to land clearance, the overall landscape context of the area is similar to that of the past. In keeping with the Burra Charter's principle that "..cultural significance may change as a result of the continuing history of the place.." it may be possible to enhance the aesthetic values of some sites, by sympathetic landscape treatment in future.

Historic Value

All Aboriginal Places can be considered to be of value to the history of the local region generally and to descendants of Traditional Aboriginal Owners in particular. All archaeological sites illustrate aspects of the past use of the landscape by Aboriginal people and all sites have the potential to provide information on changes in Aboriginal economic and technological practices in the local area prior to the arrival of Europeans. Additionally, the presence of artefacts manufactured from glass indicates that post-contact occupation occurred within the activity area. The preceding millennia and high frequency of stone artefacts recovered during testing underscores the adaptive nature of Aboriginal peoples and the adoption of new materials in the face of dramatic social upheaval that was to change landscape and its people forever.

Scientific Value

VAHR 8021-0374 has been assessed as having moderate archaeological significance overall. This site is considered to be of moderate cultural heritage significance due to the low number of artefacts present, common occurrence of this site type in the area, and some evidence of intact sub surface deposits.

Table 22: Scientific significance assessment of VAHR 8021-0374

	Site Contents	Site Condition	Representativeness	Overall Archaeological Significance
VAHR 8021-0374	2	2	1	5 (moderate)

Social Value

Many Aboriginal people regard archaeological sites as holding considerable social and cultural value, irrespective of their scientific significance. This arises not only from the material remains that represent a connection to their ancestors, but also from beliefs in the association of archaeological sites and land or 'Country'. Protection of archaeological sites and remnant sections of landscape form part of their traditional obligations to looking after 'Country', which were handed down to them by their ancestors. VAHR 8021-0374 is likely to be regarded as being of high social and cultural value to the Traditional Owners.

Spiritual Value

There has been no indication expressed by the Traditional Owners to date of any spiritual values attached to the site. However, it is recognised that all Aboriginal cultural heritage represents a spiritual connection with the land.

Statement of Significance

Comment on the cultural values and significance of Aboriginal Places can only be made by the Aboriginal community.

The following general statement of significance has been provided by the Bunurong Land Council Aboriginal Corporation:

> Over the last 35,000 years Bunurong people have adapted to a range of significant changes within their Country. Our stories of the Bay flooding with water, asteroid impacts near Cranbourne, Arthurs Seat once being an Island, volcanic activity in the western suburbs, the great floods, fires and earthquakes, all speak of such events.
>
> Over 1000 generations of our people have been here before us. Archaeological excavation within our Country has already demonstrated about 35,000 year's worth of occupation. These sites can show us how our ancestors interacted with their environment and how that interaction changed over time. We regard all evidence of our people's occupation as sacred.
>
> No amount of data can compensate for the loss of a site but if we can't literally preserve a site, the only other way it may be preserved is by way of careful data collection as part of a Cultural Heritage Management Plan (CHMP). The importance of the accuracy of this data being collected for protection is paramount as we regard this information as sacred. It holds the stories of our people and our past. In some places our archaeology is the only thing that remains within a given landscape, the only thing left that hasn't been changed or moved, and because of this, it is now sacred to us.
>
> All of our Country is highly significant, every square inch, every rock, every leaf, every dune, every artefact. If we could attribute the cause of this blanket high significance rating of our

Country to any one thing, it would be that in Melbourne especially, so much has been destroyed and lost as the city grew, and so quickly. If you lose enough of something, what little you have left becomes so much more important. Similarly, when someone passes, their earthly possessions become more important to those they left behind.

With regards to knowledge and stories, each of our Elders that passed away during early colonisation is the equivalent of a state library burning down today. One Bunurong Elder of the time was famously quoted saying that, 'Once we are gone, no one is going to know where anything is'. Clearly considering the vast amount of knowledge he and his people had collected about the landscape, all written in their songs and stories. Another Elder was noted as saying, 'one day smart people will lament at our passing', no doubt acknowledging again the ocean of information collected on every living thing here, every tree, every animal and the key to the complex balance of all things that his people had managed to evolve and sustain. European people are still learning of the complexities of Aboriginal culture.

With no written language and change occurring here so quickly, we have lost many of the ancient stories of this landscape. At the time, Bunurong people's focus was more on trying to stay alive than the luxuries of continuing to practice culture, which included the careful passing on of stories and knowledge, different levels of which would require certain initiations, performed over time.

11.0 Consideration of Section 61 Matters – Impact Assessment

In accordance with Section 61 of the *Aboriginal Heritage Act 2006*, a CHMP must consider whether the activity will be conducted in a way that avoids harm to Aboriginal cultural heritage.

Section 61 matters are a requirement of the CHMP process and are an assessment of whether:

- harm to Aboriginal cultural heritage can be avoided or minimised (s.61 (a) and (b));
- specific measures are required for the management of Aboriginal cultural heritage (s.61 (c));
- particular contingency plans are required in relation to disputes, delays and other obstacles that may affect the conduct of the activity (s.61 (d)); and
- requirements relating to the custody and management of Aboriginal cultural heritage during the course of the activity are needed (s.61 (e)).

11.1 Section 61 Matters in Relation to VAHR 8021-0374-1 (AS)

11.1.1 Can Harm to VAHR 8021-0374-1 (AS) be Avoided and/or Minimised?

During the preparation of this CHMP the Sponsor considered ways of avoiding or minimising harm to this registered Place, however as the entire surrounding area will be subject to deep sand quarrying significant issues were identified in relation to leaving this Place as an "island" of sand within the quarry area. These issues related both to OH&S concerns due to increased likelihood of collapse, as well as concern for uncontrolled loss of cultural material in the event of such a collapse.

For this reason, in accordance with Section 61 of the *Aboriginal Heritage Act 2006*, it is stated that harm to VAHR 8021-0374-1 (AS) cannot be avoided or minimised.

11.1.2 Are Specific Measures Needed for the Management of VAHR 8021-0374-1 (AS)?

Management conditions are needed to assist with mitigating harm.

Condition 2 requires a cultural heritage induction be provided for all workers involved in soil stripping works relating to the construction of the overburden stockpile area. Condition 4 requires a series of RAP inspections to occur following soil stripping events. These measures can work to mitigate harm to both known and unknown cultural deposits in the activity area.

Condition 9 requires that prior to the commencement of any works within the site extent of the Aboriginal cultural heritage Place VAHR 8021-0374 an archaeological salvage excavation must be undertaken.

Condition 8 requires the material collected from VAHR 8021-0374, including all items comprising the object collection of VAHR 8021-0369-2, VAHR 8021-0370-2, VAHR 8021-0371-2, VAHR 8021-0372-2, VAHR 8021-0373-2 and VAHR 8021-0374-2 to be reburied at a location agreed to by BLCAC and the Sponsor.

11.2 Section 61 Matters in Relation to VAHR 8021-0369-1 (AS), VAHR 8021-0370-1 (AS) and VAHR 8021-0373-1 (AS)

11.2.1 Can Harm to VAHR 8021-0369-1 (AS), VAHR 8021-0370-1 (AS) and VAHR 8021-0373-1 (AS) be Avoided and/or Minimised?

In accordance with Section 61 of the *Aboriginal Heritage Act 2006*, it is stated that harm to the location of these listed registered Places cannot be avoided or minimised. However, harm to these Places was already permitted under approved CHMP 11342, and all the recovered artefacts from these Places were reburied within the extent of VAHR 8021-0374-1 (AS) in accordance with that CHMP.

11.2.2 Are Specific Measures Needed for the Management of VAHR 8021-0369-1 (AS), VAHR 8021-0370-1 (AS) and VAHR 8021-0373-1 (AS)?

There are no specific measures needed for the management of these listed registered Places under this CHMP as the specific measures required have already been enacted in accordance with approved CHMP 11342.

11.3 Section 61 Matters in Relation to Object Collections VAHR 8021-0374-2 (OC), VAHR 8021-0369-2 (OC), VAHR 8021-0370-2 (OC), VAHR 8021-0371-2 (OC), VAHR 8021-0372-2 (OC) and VAHR 8021-0373-2 (OC)

11.3.1 Can Harm to the listed Object Collections be Avoided and/or Minimised?

For the same reasons as outlined in section 11.1.1 it is not possible to retain the extent of VAHR 8021-0374-1 (AS), which now includes the listed Object Collections. Therefore, in accordance with Section 61 of the *Aboriginal Heritage Act 2006*, it is stated that harm to VAHR cannot be avoided or minimised to listed Object Collections.

11.3.2 Are Specific Measures Needed for the Management of the listed Object Collections?

Management conditions are needed to assist with minimising harm.

Condition 8 requires the material collected from VAHR 8021-0374, including all items comprising the Object Collections of VAHR 8021-0369-2, VAHR 8021-0370-2, VAHR 8021-0371-2, VAHR 8021-0372-2, VAHR 8021-0373-2 and VAHR 8021-0374-2 to be reburied at a location agreed to by BLCAC and the Sponsor.

11.4 Necessary Contingency Plans

The approved form for a CHMP (*Aboriginal Heritage Regulations 2018*, Schedule 2, 13(1)) states that a management plan must include specific contingency plans for:

a) the matters referred to in Section 61 of the Act;

b) the resolution of any disputes between the Sponsor and relevant RAPs in relation to the implementation of the plan or the conduct of the activity;

c) reviewing compliance with the CHMP and mechanisms for remedying non-compliance;

d) the management of Aboriginal cultural heritage found during the activity; and

e) the notification, in accordance with the Act, of the discovery of Aboriginal cultural heritage during the carrying out of the activity.

There are several contingency plans that may be necessary during the conduct of this project. In particular, it is necessary to have contingency plans in place for the following:

- unexpected discovery of isolated or dispersed cultural material and for the unexpected discovery of a burial; and
- reviewing compliance with the management plan and mechanisms for remedying non-compliance.

These and other contingency plans are discussed in detail in Section 2.

11.5 Necessary Custody and Management Arrangements

All artefacts recovered during the salvage works and relocation of the object collections will be temporarily stored at the offices of the heritage advisor for the duration of these specific works. At the completion of the salvage report (within twelve months of completion of salvage works) all artefacts must be repatriated to BLCAC as per the BLCAC repatriation policy stated in Section 2.5. Further information regarding the Aboriginal cultural heritage custody and management arrangements are contained in Sections 1 and 2.

Any unexpected finds encountered during the conduct of the activity must be dealt with as per the contingencies contained in Section 2.

11.6 Cumulative Impact Statement

A CHMP is required to consider the 'cumulative impact' of the activity on Aboriginal cultural heritage within the activity area and in relation to the Aboriginal cultural heritage of the wider region.

The First Peoples-State Relations Guide to Preparing a Cultural Heritage Management Plan states that:

> *"an assessment of the likely impacts on Aboriginal cultural heritage of the activity should also include consideration and assessment of the cumulative impact of the activity on Aboriginal cultural heritage in the activity area in relation to the Aboriginal cultural heritage of the region (Aboriginal Victoria, 2016)".*

The geographic region lies beyond Melbourne's south eastern growth corridor, and as such this area has not yet been affected by the rapid urban expansion seen over the last 30 years, with the transformation from farmland to urban development. Nevertheless, several archaeological investigations in the geographic region have been associated with extractive industry due to the presence of deep sand deposits.

At the time of writing, the geographic region contained 21 registered Aboriginal Places comprising 61 components. These Place types include artefact scatters (n=21), which make up 34% of the total number of Places, LDADs, which make up 36% of the total number of Places and earth features, which make up 20% of the total number of Places. Other Aboriginal Place types include object collections (n=6). Of these Places within the geographic region, three artefact scatters are located within the current activity area (14% of all artefact scatters within the geographic region) and six object collections (100% of all object collections within the geographic region).

As it is not possible to avoid harm to these Places and object collections, it must be stated that the cumulative impact of these works is considered to be high, both within the activity area and within the wider geographic region.

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Appendix 1: CHMP Notification

VICTORIA State Government | Premier and Cabinet

Notice of Intent to prepare a Cultural Heritage Management Plan for the purposes of the *Aboriginal Heritage Act 2006*

This form can be used by the Sponsor of a Cultural Heritage Management Plan to complete the notification provisions pursuant to s.54 of the *Aboriginal Heritage Act 2006* (the "Act").

For clarification on any of the following please contact Victorian Aboriginal Heritage Register (VAHR) enquiries on 1800-726-003.

SECTION 1 - Sponsor information

Sponsor:	Hanson Construction Materials
ABN/ACN:	90009679734
Contact Name:	Gunther Benedek
Postal Address	601 Doncaster Road Doncaster VIC 3108
Business Number:	+61 3 5997 8109 | Mobile: +61 409 256 503
Email Address:	gunther.benedek@hanson.com.au

Sponsor's agent (if relevant)

Company:	Ricardo Energy, Environment & Planning
Contact Name:	Kathy McInnes
Postal Address	PO Box 33298 Melbourne 3004
Business Number:	+61 3 9978 7823 Mobile: +61 (0)437 401 554
Email Address:	Kathy.MacInnes@ricardo.com

SECTION 2 - Description of proposed activity and location

Project Name:	Proposed expansion of Yannthan Quarry: Westerport Road, Yannathan
Municipal district:	Cardinia Shire Council

Clearly identify the proposed activity for which the cultural heritage managment plan is to be prepared (ie. Mining, road construction, housing subivision)

Extractive industry

SECTION 3 - Cultural Heritage Advisor

Name	*Company*	*Email address*
Renee McAlister	Heritage Insight Pty Ltd	reneemcalister@heritageinsight.com

SECTION 4 - Expected start and finish date for the cultural heritage management plan

Start Date: 29-Jul-2020 Finish Date: 25-Feb-2021

Submitted on: 29 Jul 2020

VICTORIA State Government | Premier and Cabinet

SECTION 5 - Why are you preparing this cultural heritage management plan?

- [x] A cultural heritage management plan is required by the Aboriginal Heritage Regulations 2007

  What is the high Impact Activity as it is listed in the regulations?

  Extractive industry

  Is any part of the activity an area of cultural heritage sensitivity, as listed in the regulations? Yes
- [ ] Other Reasons (Voluntary)
- [ ] An Environment Effects Statement is required
- [ ] A Cultural Heritage Management Plan is required by the Minister for Aboriginal Affairs.
- [ ] An Impact Management Plan or Comprehensive Impact Statement is required for the activity

SECTION 6 - List the relevant registered Aboriginal parties (if any)

This section is to be completed where there are registered Aboriginal parties in relation to the management plan.

BUNURONG LAND COUNCIL ABORIGINAL CORPORATION

SECTION 7A - List the relevant Aboriginal groups or Aboriginal people with whom the Sponsor intends to consult (if any)

*This section is to be completed only if the proposed activity in the management plan is to be carried out in an area where there is **no Registered Aboriginal Party.***

SECTION 7B - Describe the intended consultation process (if any)

*This section is to be completed only if the proposed activity in the management plan is to be carried out in an area where there is **no Registered Aboriginal Party.***

SECTION 8 – State who will be evaluating this plan (mandatory)

The plan is to be evaluated by:

- [ ] Joint - Registered Aboriginal Party AND The Secretary
- [x] A Registered Aboriginal Party

  If checked, list the relevant Registered Aboriginal Party Evaluating: BUNURONG LAND COUNCIL ABORIGINAL CORPORATION
- [ ] The Secretary
- [ ] Victorian Aboriginal Heritage Council

SECTION 9 – Preliminary Aboriginal Heritage Tests (PAHTs)

List the Reference Number(s) of any PAHTs conducted in relation to the proposed activity:

SECTION 10 - Notification checklist

Submitted on: 29 Jul 2020

VICTORIA State Government | Premier and Cabinet

Ensure that any relevant registered Aboriginal party/ies is also notified. A copy of this notice with a map attached may be used for this purpose.
(A registered Aboriginal party is allowed up to 14 days to provide a written response to a notification specifying whether or not it intends to evaluate the management plan.)

In addition to notifying the Deputy Director and any relevant registerd Aboriginal party/ies, a Sponsor must also notify any owner and/or occupier of any land within the area to which the management plan relates. A copy of this notice with a map attached may be used for this purpose.

Ensure any municipal council, whose municipal district includes an area to which the cultural heritage management plan relates, is also notified. A copy of this notice, with a map attached, may also be used for this purpose.

Submitted on: 29 Jul 2020

Appendix 2: Intention to Evaluate from the BLCAC

Bunurong Land Council
ABORIGINAL CORPORATION

ABN: 66 129 413 297 ICN:3630
16/395 Nepean Hwy, Frankston VIC 3199
PO Box 11219, Frankston VIC 3199
Ph: (03) 9770 1273
www.bunuronglc.org

30 July 2020

To whom it may concern,

Notice to Evaluate Cultural Heritage Management Plan 17359 – Proposed expansion of Yannathan Quarry: Westernport Road, Yannathan.

Your notification has been accepted and the Bunurong Land Council Aboriginal Corporation (BLCAC) advises that it intends to evaluate this plan when complete, in accordance with Division 4, Section 55 of the *Aboriginal Heritage Act 2006.* We also advise that during the preparation of this plan, the BLCAC wishes to:

- Consult with you in relation to the assessment of the area for the purposes of the plan.
- Participate in the conduct of the assessment.
- Consult with the sponsor in relation to the conditions to be included in the plan.

Please note that before any fieldwork program commences it will be necessary for your heritage advisor to participate in a Project Inception Meeting to discuss the project. It is preferable for the project sponsor to attend the Project Inception Meeting. As the Project Inception Meeting provides an opportunity for all parties to clarify the aims of the CHMP and methodology for any fieldwork program, it is helpful if you and/or your heritage advisor can bring along the following information to expedite these discussions:

- A clear map of the Activity Area.
- Aboriginal site location data within the geographic region.
- Site cards of any sites already recorded in the Activity Area.
- Any geotechnical reports undertaken for the Activity Area.

To organise a Project Inception Meeting please contact the office on 0455 559 727.

Please ensure that when sending this CHMP to BLCAC for evaluation that it **must** be accompanied with proof of the evaluation fee (receipt of payment) and a hard copy of the CHMP. Failure to do so will mean the evaluation period will not commence.

If you require any additional information about this advice, please contact Angela Thompson on 0425 308 256.

We look forward to meeting with you soon to discuss the project.

Yours sincerely,

Robert Ogden
Heritage Manager
robert.ogden@bunuronglc.org.au

Appendix 3: Burra Charter Definitions and Ratings

Aesthetic value is defined as "...the sensory and perceptual experience of a place…how we respond to visual and non-visual aspects such as sounds, smells and other factors having a strong impact on human thoughts, feelings and attitudes" (Australia ICOMOS Incorporated 2013, p.3).

Historic value encompasses all aspects of history. According to the Burra Charter, "A place may have historic value because it has influenced, or has been influenced by, an historic event, phase, movement or activity, person or group of people. It may be the site of an important event. For any place the significance will be greater where the evidence of the association or event survives at the place, or where the setting is substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of such change or absence of evidence" (Australia ICOMOS Incorporated 2013, p.3).

Scientific value is defined as "…the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archaeological techniques. The relative scientific value of a place is likely to depend on the importance of the information or data involved, on its rarity, quality or representativeness, and its potential to contribute further important information about the place itself or a type or class of place or to address important research questions" (Australia ICOMOS Incorporated 2013, p.3).

Scientific significance is assessed by examining the research potential and representativeness of archaeological sites. The scientific significance assessment methodology is based on scores for research potential (divided into site contents and site condition) and for representativeness. This system is refined and derived from Bowdler (1981) and Bowdler and Sullivan (1984).

Research potential is assessed by examining 'site contents' and 'site condition'.

'Site contents' denotes all cultural materials and organic remains associated with human activity at a site. 'Site contents' also denotes the structure of the site – the size of the site, the patterning of cultural materials within the site, the presence of any stratified deposits and the rarity of particular artefact types.

'Site condition' denotes the degree of disturbance to the contents of a site at the time it was recorded.

The site contents ratings used for the scientific significance assessment are:

0. No cultural material remaining

1. Site contains a small number (e.g. 0–10 artefacts) or limited range of cultural materials with no evident stratification.

2. Site contains:
(a) a larger number, but limited range of cultural materials; and/or
(b) some intact stratified deposit remains; and/or
(c) rare or unusual example(s) of a particular artefact type.

3. Site contains:
(a) a large number and diverse range of cultural materials; and/or
(b) largely intact stratified deposit; and/or
(c) surface spatial patterning of cultural materials that still reflect the way in which the cultural materials were deposited.

The site condition ratings for the archaeological site described in this CHMP are:

0. Site destroyed.

1. Site in a deteriorated condition with a high degree of disturbance; some cultural materials remaining.

2. Site in a fair to good condition, but with some disturbance.

3. Site in an excellent condition with little or no disturbance. For surface artefact scatters this may mean that the spatial patterning of cultural materials still reflects the way in which the cultural materials were laid down.

Representativeness refers to the regional distribution of a particular site type. Representativeness is assessed by whether the site is common, occasional, or rare in a given region. Assessments of representativeness are subjectively biased by current knowledge of the distribution and number of archaeological sites in a region. This varies from place to place depending on the extent of archaeological research. Consequently, a site that is assigned low significance values for contents and condition but a high significance value for representativeness can only be regarded as significant in terms of knowledge of the regional archaeology. Any such site should be subject to re-assessment as more archaeological research is undertaken.

Assessment of representativeness also takes into account the contents and condition of a site. For example, in any region there may only be a limited number of sites of any type that have suffered minimal disturbance. Such sites would therefore be given a high significance rating for representativeness, although they may occur commonly within the region.

The representativeness ratings used for the scientific significance assessment are:

1. Common occurrence.
2. Occasional occurrence.
3. Rare occurrence.

Overall scientific significance ratings for sites, based on a cumulative score for site contents, site integrity and representativeness are:

1–3 Low scientific significance.
4–6 Moderate scientific significance.
7–9 High scientific significance.

Social value is defined as "...the associations that a place has for a particular community or cultural group and the social or cultural meanings that it holds for them" (Australia ICOMOS Incorporated 2013, p.4).

Spiritual value is defined as "…the intangible values and meanings embodied in or evoked by a place which give it importance in the spiritual identity, or the traditional knowledge, art and practices of a cultural group. Spiritual value may also be reflected in the intensity of aesthetic and emotional responses or community associations and be expressed through cultural practices and related places" (Australia ICOMOS Incorporated 2013, p.4).

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Appendix 4: Glossary

Aboriginal Cultural Heritage Any Aboriginal ancestral remains, Aboriginal object and/or Aboriginal Place.

Aboriginal Ancestral Remains The remains of an Aboriginal person.

Aboriginal Object An object that relates to, or is a result of, Aboriginal occupation of Australia and includes objects and artefacts discovered during ground survey or excavation. Aboriginal objects include, but are not limited to, stone artefacts (lithics), non-human bone artefacts, and faunal remains.

Aboriginal Place An area which is of cultural heritage significance to Aboriginal people and can include an area of land, an expanse of water, a natural feature, formation or landscape, and an archaeological site, feature or deposit.

Adze A flake with stepped retouch along lateral margins that can be hafted for use as a tool.

Anvil A flat object on which a core was placed to flake material from. Anvils often have a small pit/groove, usually in the centre of the object, as a result of this action.

Archaeology The study of cultural remains from past cultures and generations.

Artefact Scatter The material remains of past Aboriginal peoples' activities. Usually contain stone artefacts, but other material may also be present, including charcoal, animal bone, shell and ochre. An artefact scatter is usually represented by a single stone flake or a concentration of flaked stone pieces (or fragments).

Assemblage A collection of artefacts that are derived from the same site.

Australian Small Tool Tradition Stone tool assemblages characteristic of hunter-gatherer communities across Australia, but not Tasmania, during the period 3000 BC through to European contact. The tool types represented include hafted implements, such as Bondi points, a range of bifacial and unifacial points and projectile tips, microliths in geometric forms, and a variety of blade-based items.

Backed Blade A stone artefact associated with the Australian Small Tool Tradition. They are characterised by unidirectional or bidirectional retouch found along a lateral margin, thought to be blunt for hafting (Holdaway & Stern 2004, p.260).

Basalt A fine-grained rock occurring from lava flows.

Bifacially Flaked Flakes removed from two faces of an object such as a core.

Blade A flake that is twice as long as it is wide.

Bondi Point An asymmetrical blade with a point at one end with backing retouch. Part of the Australian Small Tool Tradition.

Burial Human Remains, normally found as concentrations of human bones or teeth, exposed by erosion or earthworks. They are sometimes associated with charcoal or ochre, although shell, animal bone and stone tools may also be present. Tend to be located in soft soils and sand, although can occur in rock shelters, caves and dead trees.

Burin A truncated flake formed by snapping or retouching along one lateral margin that then forms a platform from which small flakes are removed forming a triangular scar that acts as a working edge (Holdaway & Stern 2004, p.241-243).

Ceramic A term used to identify wares made from either clay or fusible stone such as stoneware, earthenware, porcelain or terracotta (Davies & Buckley 1987, p.186).

Chert A compact, fine-grained rock made of crypto-crystalline silica and can occur in a variety of colours, usually red, green or black.

Core A specimen of rock that has undergone a process of reduction through the removal of a number of flakes and as a result they have negative flake scars. Cores can contain a single platform, have two platforms or have had flakes removed in multiple directions.

Cortex The original surface of a mineral or rock subjected to weathering by the elements.

Cultural Material Any material remains which are produced by human activity.

Debitage Detached pieces of stone that are discarded during the reduction process of stone tool manufacture.

Dry Stone Wall A wall formed of a number of courses of rock (usually basalt or limestone) with no bond or binding component. Walls are usually tapered, have two faces and can have hearting (packing), or plugging.

Earthenware A non-vitreous (porous) whiteware, usually used for domestic tablewares. Most earthenware is glazed and decorated, transfer printed or left plain (Davies & Buckley 1987, p.186).

Earth Feature Collective term used to refer to mounds, rings, hearths, postholes and ovens.

Earth Mound Mounds generally appear as raised areas of darker soil. They are commonly found in the volcanic plains of western Victoria or on higher ground near water bodies. Mounds often contain charcoal, burnt clay or stone heat retainers from cooking ovens, animal bones, shells, stone tools and sometimes, Aboriginal burials.

Earth Ring Banked circles of soil often associated with stone arrangements, which had a ceremonial purpose for Aboriginal people in the past.

Excavation A controlled means of soil disturbance (digging) allowing for detailed recording of the soil profile, features and artefacts exposed.

Flake A stone artefact that contains characteristics such as the presence of a platform, bulb of percussion and termination which reveal that the stone has been struck from a core and is the result of stone working (Holdaway & Stern 2004, p.5).

Flake Core A flake that has subsequently been used as a core and had other flakes removed from it.

Flaked Piece Small fragments of stone that have been removed from flakes resulting from tool maintenance or tool production (Holdaway & Stern 2004, p.17). Flaked pieces do not display the characteristics evident in a complete flake.

Flint Similar to chert with a pale cortex and conchoidal fracture. Usually occurring in limestone (Roberts 1998, p.65).

Footing The structural base/footprint from structures often built from bluestone, brick or wooden posts.

Geometric Microlith A stone tool that is part of the Australian Small Tool Tradition. They are symmetrical in form, pointed at both ends, and can be backed along a lateral margin (Holdaway & Stern 2004, p.262).

Glaze A coating put over wares fired in a kiln. Glazes can come in a variety of colours and can also be transparent.

Greenstone A metamorphic rock derived from basalt containing feldspar and quartz and is made green by chlorite and epidote. Often used for the manufacture of hand axes.

Grindstone A flat slab of rock with central depression used to grind, crush or pound seeds, ochre, or sharpen tools, etc. Grindstones are usually made on sedimentary rocks with an abrasive surface.

Ground Edge Axes A stone tool produced by a particular sharpening process – flaking, pecking and polishing, usually along a single lateral margin. The axes are generally hafted with the worked edge forming the tool edge.

Ground Surface Visibility The extent to which the natural soil surface below the vegetation on the ground is visible.

Hammerstone A hard rock or mineral used to flake fragments of stone from a core (Holdaway & Stern 2004, p.4).

Hearth The remains of a fireplace containing charcoal and sometimes burnt earth, bone, stone artefacts or other organic material.

In situ An artefact or feature that remains in its original position, or where it was left.

Manuport A stone artefact that is a stone block that displays no attributes of being either a core or a flake.

Microblade A stone tool that has the same characteristics as a blade but just of smaller proportions (Holdaway & Stern 2004, p.17).

Ochre Earth varying in colour from yellow to red, used as a pigment.

Organic Compounds formed from living organisms (plants or animals).

Oven Mound Usually circular or oval in shape and often situated close to a water source. They were used for cooking and contain a rich greasy organic mix of soil and organic material. An oven mound is likely to contain charcoal, burnt clay or stone heat retainers, stone tools, bones, shell and on occasion, burials (AAV Mini Poster 4).

Platform The surface from which the flake was struck off the core – can be natural, flaked or abraded (Holdaway & Stern 2004, p.120).

Point A flake that has two edges that form a point with retouch along one or both lateral margins (Holdaway & Stern 2004, p.16).

Porcelain A non-porous ceramic with a glass-like appearance. Can be translucent, can be used for tableware or more decorative features such as ornaments.

Post-Contact The period after contact between Aboriginal people and Europeans.

Pre-Contact The period before contact between Aboriginal people and Europeans.

Quarry Outcrop of stone or ochre that has been quarried by Aboriginal people in the past. Generally associated with a large amount of broken stone and flakes. The outcrop (cores) bear negative scars from flaking.

Quartz A mineral that commonly occurs in sedimentary, igneous and metamorphic rocks. Quartz can come in a number of forms including crystal, rose, and smoky.

Quartzite A metamorphic rock formed by the re-crystallization of quartz. Quartz is rich in sandstone and limestone (Roberts 1998, p.109).

Retouch A worked edge or modification of a flake formed by removing a number of small flakes along an edge. This can be done as a form of maintenance or to produce a tool.

Rock Art Paintings created on the rock surfaces of caves and rock shelters and engravings in limestone caves. Artwork includes stencils, prints and drawings. The paint consists of ochres, clays and charcoal mixed with fats.

Scarred Tree A tree which has had a slab of bark removed, exposing the sapwood on the trunk or branch of a tree. Aboriginal people used the bark to make shelters, containers (coolamons) and canoes.

Scraper A flake with at least one edge that has continuous retouch. Scraper types include steep-edged, end, side and nose scraper (Holdaway & Stern 2004, p.16).

Shell Midden A surface and/or subsurface deposit composed of shell and sometimes stone artefacts, charcoal and bone. Middens are normally found in association with coastlines, rivers, creeks and swamps – wherever coastal, riverine or estuarine shellfish resources were available and exploited.

Silcrete A fine-grained rock derived from shale or siltstone mixed with silica.

Spit A horizontal unit of soil removed during excavation. Spits can be arbitrary (dug to a depth of 50, 100, 200, 300mm, etc.) or can be confined to a particular soil type or context. The excavation of spits allows for greater understanding, analysis and interpretation of the soil profile.

Stone Feature Includes cairns, rock wells, stone arrangements, fish traps, stone structures and grinding grooves. May be a natural feature, which was used or modified to be used by Aboriginal people in the past (rock well, stone arrangement), or a stone feature which has been deliberately constructed for a specific purpose (fish trap, stone structure, cairn), or is the result of a specific activity carried out by Aboriginal people in the past (grinding grooves).

Stoneware A vitreous (non-porous) ceramic, usually light brown in colour, used for drinking containers or used industrially. Often glazed or unglazed (salt glaze or slip applied) (Davies & Buckley 1987, p.186).

Stratification The position of sediments and rocks in the ground in sequence throughout time.

Subsurface Testing A method of excavation that involves ground disturbing works to identify the potential for cultural material. Subsurface testing may comprise hand excavation and/or machine excavation.

Survey An inspection of land either by foot or by car (windscreen survey) noting conditions on surface visibility, landforms and the presence of cultural material.

Termination The shape of the distal end of a flake (Holdaway & Stern 2004, p.129).

Terracotta A low-fired clay (ceramic), usually orange to red in colour and very porous. Often used for plumbing (drainage components) or garden ware.

Tool Modified flakes usually with retouch present along an edge (Holdaway & Stern 2004, p.33).

Transect An excavated stretch of ground that can be of varying lengths in a straight line.

Transfer Printed A design is traced and engraved onto a copper plate on which ink and oil is then applied. The design is pressed onto tissue paper and then placed on an object and the paper removed. The object is then fired and glazed. Transfer printed ceramics come in a variety of colours and patterns and were mass produced.

Trench An area confined by excavation usually in the form of a square (e.g., 2x2m) or rectangular (e.g., 1.5x1m).

References

AAV Mini Posters (1–7).

Davies, M & Buckley, K 1987, *Port Arthur Conservation & Development Project: Archaeological Procedures Manual*, Occasional Paper No.13. Department of Lands, Parks and Wildlife, Tasmania.

Holdaway, S & Stern, N 2004, *A Record in Stone: The Study of Australia's Flaked Stone Artefacts*, Museum Victoria and Aboriginal Studies Press, Melbourne.

Roberts, JL, 1998, *A Photographic Guide to Minerals, Rocks and Fossils*, New Holland, London.

Appendix 5: Site Gazetteer

VAHR No.	VAHR Name	Site Type	Coordinates (GDA 94) (Zone 55)	Landform	Landform Element	Soil	Nearest Potable Water Source	Vegetation
8021-0369	Yannathan IA 1	Isolated artefact	380501E 5765502	Sandy Rise	Midslope	Sand	Lang Lang River	Agricultural
8021-0370	Yannathan IA 2	Isolated artefact	380309E 5765548N	Sandy Rise	Top of Rise	Sand	Lang Lang River	Agricultural
8021-0373	Yannathan AS 5	Artefact Scatter	3801009E 57655471N	Sandy Rise	Top of Rise	Sand	Lang Lang River	Agricultural
8021-0374	Yannathan AS 6	Artefact Scatter	380967E 5765515N	Sandy Rise	Top of Rise and slope	Sand	Lang Lang River	Agricultural

VAHR No.	VAHR Name	Site Aspect	Ground Surface Visibility	Maximum Dimensions N-S	Maximum Dimensions E-W	Disturbance to Site	Condition	Integrity
8021-0369	Yannathan IA 1	Surface	5%	N/A	N/A	Soil highly churned up through animal use and construction of nearby well.	Poor	Eroding
8021-0370	Yannathan IA 2	Subsurface	<5%	N/A	N/A	None Noted	Poor	*In situ*
8021-0373	Yannathan AS 5	Subsurface	<5%	70m	9m	None Noted	Good	*In situ*
8021-0374	Yannathan AS 6	Subsurface	<5%	55m	93m	None Noted	Good	*In Situ*

Appendix 6: Artefact Catalogue for Sites within Activity Area

Site	Transect #	SP#	Artefact #	Spit #	X,Y	Z (depth)	Sieve Y/N	Artefact Type	Raw Material	Cortex (%)	Complete (Y/N)	L (mm)	W (mm)	T (mm)	MD (mm)	Weight (g)	No. Negative Flake Scars (Cores Only)	Flake Portion (Broken Flake Only)	Flake Form (Complete Only)	Platform Type (Complete Only)	Termination Type (Complete Only)
Yannathan AS 4	5		4	100-110cm			N	Broken Flake	Silcrete	25-50	Y	24.72	20.31	5.95				95%			Feather
Yannathan AS 4	5		5	90-100cm			N	Angular Fragment	Silcrete	0					20.47						
Yannathan AS 4	5		6	90-100cm			N	Angular Fragment	Milky Quartz	0					17.17						
Yannathan AS 4	5		7	90-100cm			N	Angular Fragment	Silcrete	0					15.45						
Yannathan AS 4	20		28	70-80cm			N	Broken Flake	Milky Quartz	0	N	26.01	16.76	6.14						Plain	
Yannathan AS 4	20		29	100-110cm			N	Broken Flake	Silcrete	0	N	13.37	9.12	2.38						Plain	
Yannathan AS 4	23		31	50-60cm			N	Angular Fragment	Silcrete	0					13.41						
Yannathan AS 4	23		32	50-60cm			N	Angular Fragment	Milky Quartz	0					9.2						
Yannathan AS 4		32	38	20-30cm			N	Complete Flake	Quartzite	0	Y	25.99	17.44	6.05					Regular	Flaked	Abrupt
Yannathan AS 4		35	39	20-30cm			N	Complete Flake	Silcrete	0	Y	21	11.1	6.44					Irregular	Plain	Feather
Yannathan AS 4		35	40	0-10cm			N	Core	Quartzite	0	Y	38.72	58.37	20.56			5			Plain	
Yannathan AS 5	6		8	50-60cm			N	Angular Fragment	Milky Quartz	0					12.74						
Yannathan AS 5	6		9	50-60cm			N	Angular Fragment	Silcrete	0					13.09						
Yannathan AS 5	6		10	50cm			N	Broken Flake	Silcrete	0	N	9.34	6.9	2.57				95%		Flaked	Feather
Yannathan AS 5	6		11	50-60cm			N	Broken Flake	Silcrete	0	N	31.64	20.16	5.19				95% (distal)	Regular		Feather
Yannathan AS 5	6		12	50-60cm			N	Broken Flake	Silcrete	0	N	26.7	7.54	3.75				95% (distal)	Blade		Abrupt
Yannathan AS 5	6		13	50-60cm			N	Complete Flake	Silcrete	0-25	Y	29.91	34.68	10.35					Irregular	Flaked	Plunge
Yannathan AS 5	6		14	50-60cm			N	Complete Flake	Quartzite	0	Y	32.67	36.97	10.26					Regular	Crushed	Feather
Yannathan AS 5	6		15	50-60cm			N	Angular Fragment	Silcrete	0					8.47						
Yannathan AS 5	6		16	60-70cm			N	Angular Fragment	Quartzite	0					8.64						
Yannathan AS 5	7		17	40-50cm			N	Core	Silcrete	0	Y	32.02	21.91	16.93			3		Irregular	Plain	
Yannathan AS 5	22		30	50-60cm			N	Complete Flake	Quartzite	0	Y	20.3	16.25	2.73					Regular	Flaked	Feather
Yannathan AS 6		6	35	40-50cm			N	Angular Fragment	Silcrete	0					13.14						
Yannathan AS 6		6	36	40-50cm			N	Broken Flake	Silcrete	0	N	10.21	14.31	3.28				Proximal		Crushed	
Yannathan AS 6	8		18	20-30cm			N	Complete Flake	Silcrete	0	Y	11.1	6.43	2.07					Regular	Crushed	Feather
Yannathan AS 6	8		19	20-30cm			N	Complete Flake	Silcrete	0	Y	7.31	9.64	2.44					Irregular	Plain	Feather
Yannathan AS 6	9		20	40-50cm			N	Angular Fragment	Quartzite	0					9.79						
Yannathan AS 6	10		21	30-40cm			N	Complete Flake	Silcrete	0	Y	7.82	15.33	2.63					Irregular	Plain	Feather
Yannathan AS 6	10		22	30-40cm			N	Broken Flake	Chert	0	N	16.85	13.06	2.51				95% (proximal)		Crushed	
Yannathan AS 6	10		23	40-50cm			N	Complete Flake	Silcrete	0	Y	34.72	20.52	11.87					Irregular	Plain	Abrupt
Yannathan AS 6	10		24	40-50cm			N	Angular Fragment	Silcrete	0					14.92						
Yannathan AS 6	10		25	40-50cm			N	Angular Fragment	Silcrete	0					8.64						
Yannathan AS 6	10		26	40-50cm			N	Angular Fragment	Silcrete	0					9.95						
Yannathan AS 6	24		34	30-40cm			N	Broken Flake	Milky Quartz	0	N	25.65	15.42	4.11				85%		Crushed	Hinge
Yannathan IA 1	Surface		33	Surface			N	Angular Fragment	Silcrete	0-25					19.22						
Yannathan IA 2	14		27	30-40cm			N	Complete Flake	Silcrete	0	Y	31.27	20.77	7.25					Regular	Crushed	Feather
Yannathan IA 3	1		3	90-100cm			N	Complete Flake	Silcrete	0	Y	16.26	8.45	2.4					Irregular	Flaked	Feather
Yannathan IA 3		TP8	2	80-90cm			Y	Complete Flake	Quartzite	0	Y	20.57	12.04	6.6					Regular	Plain	Feather

15 December 2023

PROPOSED SAND QUARRY EXPANSION, YANNATHAN, VICTORIA

870-910 WESTERNPORT ROAD

YANNATHAN, VICTORIA 3984

GEOTECHNICAL ASSESSMENT

Hanson Construction Materials, c/o Ricardo Energy, Environment and Planning

MEL2022-0033AE Rev 2

MEL2022-0033AE		
Date	**Revision**	**Comments**
10 February 2023	0	Draft Report
3 May 2023	1	Issued
15 December 2023	2	Revised with additional data

	Name	Signature	Position
Prepared by	John V. Smith		Senior Principal Engineering Geologist
Reviewed by	John McCaffrey		Senior Principal Geotechnical Engineer

COMPASS ASSURANCE SERVICES ISO 9001
COMPASS ASSURANCE SERVICES ISO 45001
COMPASS ASSURANCE SERVICES ISO 14001

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List of Geotechnical Terms

CPeT-iT: CPT/CPTu interpretation software

CPT: Cone penetrometer test

CPTu: Cone penetrometer test with pore water pressure measurement

DCP: Dynamic cone penetrometer

DPSH: Dynamic probing super heavy

FoS: Factor of safety

Landbridge: A natural or constructed embankment separating parts of an excavation and used as a roadway

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EXECUTIVE SUMMARY

CMW Geosciences (CMW) has been engaged by Hanson Construction Materials (Hanson) to carry out a geotechnical assessment for the planned expansion of the sand quarry at Yannathan, in the State of Victoria. The study and proposed Work Plan Variation are being coordinated by Ricardo Energy, Environment and Planning (Ricardo).

CMW was engaged as a geotechnical specialist consultant to assist Hanson during the application for the proposed sand quarry. The geotechnical assessment and analysis presented in this report has been prepared for the proposed expansion project.

Based on the agreed scope of works the following findings are presented:

1. A desktop study was conducted including a detailed review of relevant site information, existing mapping data and site hydrogeological investigations. The study was supported by a site walkover by the author of this report. The results of laboratory testing of organic sand from a 30 m deep drillhole at Lang Lang sand quarry 5 km southwest of this site has also been included in the desktop review.

2. An initial site geological and geotechnical model has been developed based on the results of the desktop review.

3. Site investigation comprised three days of cone penetration testing (CPT) which was conducted across the site in January 2023. The results of the investigations have been used in assessing design strength parameters for analysis of natural clay and sand layers and for constructed batters.

4. Slope stability analyses have been conducted using batter geometry profiles discussed during the site walkover and in communication with the client. Limit-equilibrium analyses of rotational slope failure and sliding of the clay buttress under the effect of water pressure have been conducted. The upper slopes (+9m RL to surface) would be excavated at 1:2.5 (V:H) and buttressed during site stripping with clay fill at terminal/rehabilitated faces, at a gradient of 1:3 (V:H). A gradient of 1:5 (V:H) would be incorporated in the slope from surface to the expected rehabilitated water level. Water inflow from sand faces and water pressure on the clay buttress will increase as excavation depth increases. It is recommended that these parameters are carefully recorded as the excavation proceeds below +9 mRL so that models and assumptions can be confirmed with the observations. Deepening of the excavation to -9 mRL by dredging has been included in the analysis. The dredged lower slopes can be excavated at 1:2 (V:H). Slope stability analysis has been conducted on a representative land bridge/embankment adjacent to placed filter cake. Filter cake properties were derived from CPT through a previously deposited impoundment. Limit-equilibrium and finite element analysis showed acceptable stability could be achieved will the typical geometry used at the site.

5. The factors of safety (FoS) of the upper slope (+9 mRL to surface) with a clay buttress emplaced are above 1.6 for static conditions. The sand slopes prior to buttressing have FoS less than 1.6 and are assessed as acceptably stable based on the site experience of placing buttresses progressively with site extraction. Operational upper slopes in sand at a gradient of 1:2.5 are expected to be stable on the basis that limited faces are exposed prior to placing of clay buttressing on terminal/rehabilitated slopes. The lower slope could be excavated by dredging at a gradient of 1:2 (V:H). The dredging boom geometry should be assessed to identify a series of cutting faces that will conform to the overall recommended gradient.

6. The stability of the proposed design batter geometries for the operational, terminal and rehabilitation geometries has been assessed in accordance with the Department of Jobs, Precincts and Regions (DJPR) 2020 'Geotechnical guideline for terminal and rehabilitated slopes – Extractive Industry Projects'.

7. The slopes of embankments for impoundments of water and fine waste materials have also been assessed with reference to the ANCOLD (2012, 2019) guideline on tailings dams. The recommended slopes meet stability requirements.

8. The slope stability analyses also show that the recommended slopes are stable for a 1 in 500 year seismic event based on Geoscience Australia data.

9. The geotechnical risk assessment has identified suitable risk treatment protocols for identified hazards. The residual risks are considered to be low or medium.

10. Preliminary consideration of the erodibility of the proposed rehabilitation slope design indicate that a final slope with low erosion potential can be achieved at the site.

11. This geotechnical assessment report outlines the findings and recommendations, which support a Work Plan Variation for the proposed expansion area.

12. A Ground Control Management Plan (GCMP) incorporating trigger action response plans (TARPs) is provided as a separate report.

13. A fill specification to facilitate construction of the diverted waterway is included as an Appendix to this report.

13 a. It is understood that the waterway is to be located over clay buttressing placed along the northern perimeter of the proposed expansion area. The clay fill, if placed in accordance with the specifications provided, is expected to provide an appropriate limit to infiltration to allow the constructed waterway to perform in a similar way to natural waterways in the area. The thickness of the clay buttress is expected to prevent water infiltration to represent a risk to the excavation in the expansion area. An artificial lining of the waterway channel is not recommended if the fill specifications for material selection, methods of compaction and testing are achieved.

13 b. Monitoring requirements to ensure that the constructed waterway is not creating a risk to the excavation area include visual observations and surveying as outlined in the risk assessment in this report and GCMP.

1 INTRODUCTION

1.1 General Background

Hanson Construction Materials (Hanson) commissioned an initial desk study by purchase order 4503008784 on 16th March 2022. The scope of works is outlined in the CMW proposal MEL2022-0033 Proposal AA Rev 0 dated 6th March 2022. CMW Geosciences (CMW) was further authorised by Hanson Construction materials to carry out a geotechnical investigation to assess the existing site ground conditions for the proposed quarry expansion at Yannathan Sand Quarry. The scope of works is outlined in CMW's services proposal MEL2022-0033 AD Rev0 dated Dec 2022. CMW's work will contribute to a study and Work Plan Variation submission coordinated by Ricardo Energy Environment and Planning (Ricardo).

A site walkover was previously conducted by CMW on 18th March 2022 guided by Quarry Manager, Mr Gunther Benedek. Following the site walkover CMW produced a geotechnical assessment and analysis report (MEL2022-0033 AB Rev2) dated 1 September 2022.

In Rev 1 of this report, Cone Penetrometer Tests with pore pressure measurement (CPTu) data collected on site was interpreted to develop geotechnical sections, estimate material properties across the site and assess liquefaction risk.

New information arising from the CPTu has been used to assess geotechnical risk following the 'Geotechnical guideline for terminal and rehabilitated slopes, Extractive industry projects' (September 2020) Earth Resources Regulation (ERR), which provides guidance on the approach for geotechnical aspects and risks regarding extractive industry in Victoria. The geotechnical risk of existing and proposed water and tailings impoundments has also been assessed with respect to ANCOLD (2012, 2019).

In Rev 2 of this report (the current revision), triaxial testing of undisturbed sand samples from Lang Lang quarry has been used to inform the material parameter selection.

1.2 Project Background

CMW understand that Hanson have identified a sand resource between the existing Yannathan operations and Westernport Road. Sand extraction is proposed to expand northward to extract this resource and process the sand to supply the high level of demand for construction sand in Victoria.

A waterway is presently running from east to west through the proposed expansion area. The proposed expansion involves constructing a waterway diversion along the northern part of the expansion area. The waterway diversion is expected to have similar features to the previously constructed waterway diversion in the eastern part of the site.

Where possible, the waterway diversion construction would be integrated into the progressive extraction of the sand resource.

Documents provided for the geotechnical assessment include the following:

- Pioneer Concrete 1998
- Geotechnical Investigation Chadwick 2003

- Dames and Moore advice from Resource evaluation report
- Geotechnical Risk Zone GHD 2013
- Recent resource drilling (Excel spreadsheet file)
- Core photos – Yannathan sand drilling 2019
- ENGENY, December 2021, Geomorphic Assessment, Hanson Construction Materials Yannathan Quarry, V1259_003_REP_001_2
- Hydrogeology Modelling Report, GWS, 2021, Hanson, Yannathan Quarry

The rehabilitation plan for the site is understood to involve voids in the area of the main extraction pits which will be allowed to refill with water to create waterbodies. The central part of the site, which currently contains the processing area and pits refilled with the filter cake, is currently being revegetated with native vegetation which will continue through the time of the proposed expanded operation. The existing pits in the eastern part of the site are to be filled with filter cake.

1.3 Scope of Work

According to the brief provided, the assessment includes the following:

Table 1: Scope of work with reference to the relevant section of the report	
1. A desktop study including a detailed review of relevant site information, existing mapping data and site hydrogeological investigations.	Section 2,3
2. Develop a site geological and geotechnical model based on the results of the desktop review.	Section 3
3. Geotechnical field investigation consisting of CPTu, DPSH and DCP testing. Including: • Analysis of CPTu data to classify subsurface material and develop geotechnical sections (using software CPeT-iT). • Estimation of material parameters and classification of material density / stiffness from CPTu, DPSH and DCP data • Assessment of liquefaction risk	Section 4,5
4. Undertake slope stability analyses using Client supplied batter geometry profiles for the proposed development at the site. Dredging is intended for excavation below +9 mRL.	Section 6
5. Identify and justify factors of safety for the expansion.	Section 5,6
6. Assess the stability of the proposed design batter geometries (for the operational, terminal and rehabilitation geometries) in accordance with the Department of Jobs, Precincts and Regions (DJPR) 2020 'Geotechnical guideline for terminal and rehabilitated slopes – Extractives Industry Projects' (referred to as the geotechnical guidelines).	Section 6, Appendix D
7. Report on filter cake disposal method and proposed future options (including ANCOLD dam safety assessment and input for TARPS)	Section 6

8. Undertake slope stability analyses for a 1 in 500 year seismic event.	Section 4, Appendix C
9. Undertake a geotechnical risk assessment which identifies, where necessary, suitable risk treatment protocols for identified hazards using the risk assessment matrix in Preparation-of-Work-Plans-and-Work-Plan-Variations-Guideline-for-Extractive-Industry (ERR, Dec 2020) referred to as the Work Plan Guidelines.	Section 6, Appendix D
10. Undertake preliminary erodibility assessments, based on the proposed rehabilitation slope design,	Section 7
11. Prepare a geotechnical report (this report) outlining the findings and recommendations, which can be subsequently submitted to the ERR as part of the WPV application submission.	This report
12. Preparation of a Ground Control Management Plan (GCMP) incorporating trigger action response plans (TARPs).	Separate report MEL2022-0033 AC
13. Preparation of a fill specification to facilitate construction of waterway:	Appendix E
13 a. Identification of construction requirements for waterway (eg need for lining – clay/LLDPE)	Appendix E
13 b. Identification of monitoring requirements	Appendix E & GCMP

2 SITE DESCRIPTION

2.1 Published Geology and Groundwater

2.1.1 Geology

The site is within the Cainozoic sedimentary and volcanic rocks of the Westernport Basin, in west Gippsland, Victoria (Birch, 2003). Sandstones and mudstones of the Cretaceous aged Strzelecki Group and Lower Paleozoic granite/granodiorites form the basement. East-west to southeast-northwest extension formed normal faults and the Westernport Basin itself. Volcanic rocks are basalts of the Neerim Volcanic Group formerly known as an undifferentiated part of Victoria's Older Volcanics.

Tertiary sediments below the volcanics are known as the Childers Formation. The Childers Formation comprises coarse quartzose sand and gravel with carbonaceous beds. Tertiary sediments overlying the volcanics have been mapped as Yallock Formation. The Yallock Formation comprises medium to coarse quartzose sand and gravel which is locally carbonaceous. Locally, the Tertiary sedimentary deposition was structurally controlled, bounded to the west by the Lang Lang fault and to the east by the Heath Hill Fault.

The project location has surface deposits of Quaternary alluvium comprising dune sand and clayey sand deposits. These Quaternary sediments include medium to coarse quartzose sands deposited in an aeolian environment and Quaternary clays with minor sand and gravel interbeds.

The underlying Tertiary sedimentary deposits correspond regionally to the Brighton Group (Figure 1, 2 and 3). The Tertiary sediments are also known as Sandringham Sandstone (formerly also locally known as the Baxter Sandstone). According to Geoscience Australia Stratigraphic Units Database, Geoscience Australia (https://asud.ga.gov.au) "This newly redescribed unit [Sandringham Sandstone] is intended to replace Hanson Plain Sand, Moorabool Viaduct Sands, Baxter Sandstone, Marina Cove Sand, Black Rock Sandstone, Red Bluff Sandstone, Beaumaris Sandstone, Brighton Group" (Table 2). The lower part of the Tertiary sedimentary deposits overlying the volcanic rocks (Neerim Volcanic Group formerly known as Older Volcanics) has been referred to locally as the Yallock Formation.

Table 2: Terminology related to stratigraphy

Currently accepted term[1]	Commonly used terms	Local terms
Sandringham Sandstone	Brighton Group[2] Haunted Hills Formation[3]	Hanson Plain Sand, Moorabool Viaduct Sands, Baxter Sandstone, Marina Cove Sand, Black Rock Sandstone, Red Bluff Sandstone, Beaumaris Sandstone, Yallock Formation

[1] According to Geoscience Australia Stratigraphic Units Database, Geoscience Australia (https://asud.ga.gov.au)
[2] Peck, W.A., Neilson, J.L., Olds, R.J. and Seddon, K.D. eds., 1992. *Engineering Geology of Melbourne*. CRC Press.
[3] Warragul geological map (1:250,000)

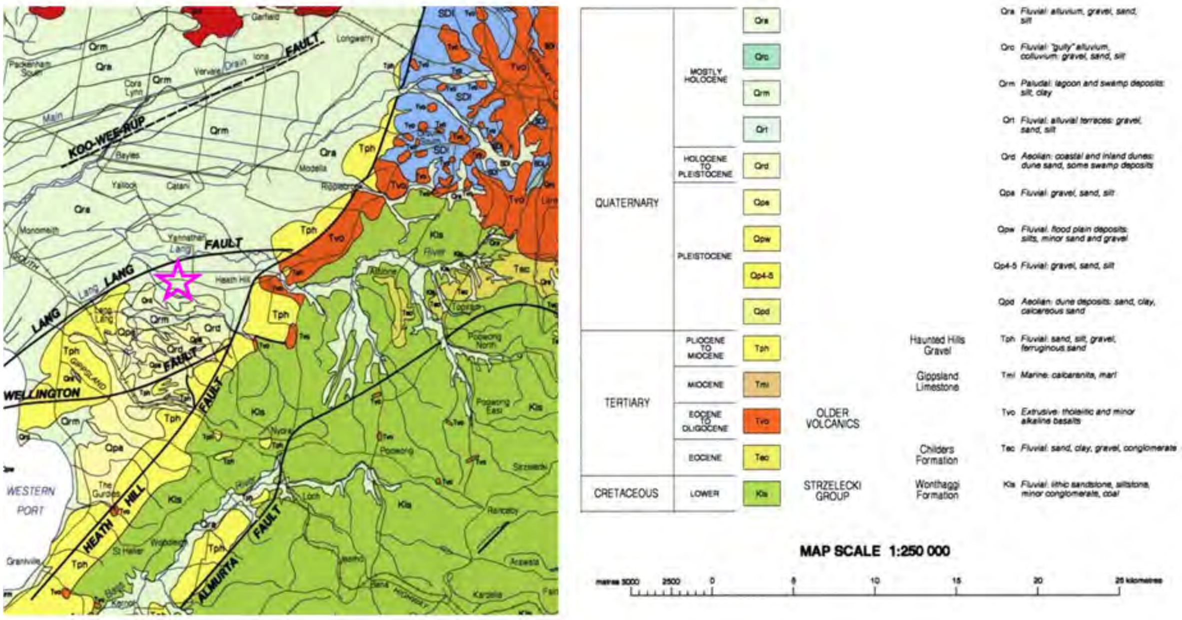

Figure 1: Regional geology in the project area marked by star (Warragul geological map 1:250,000)

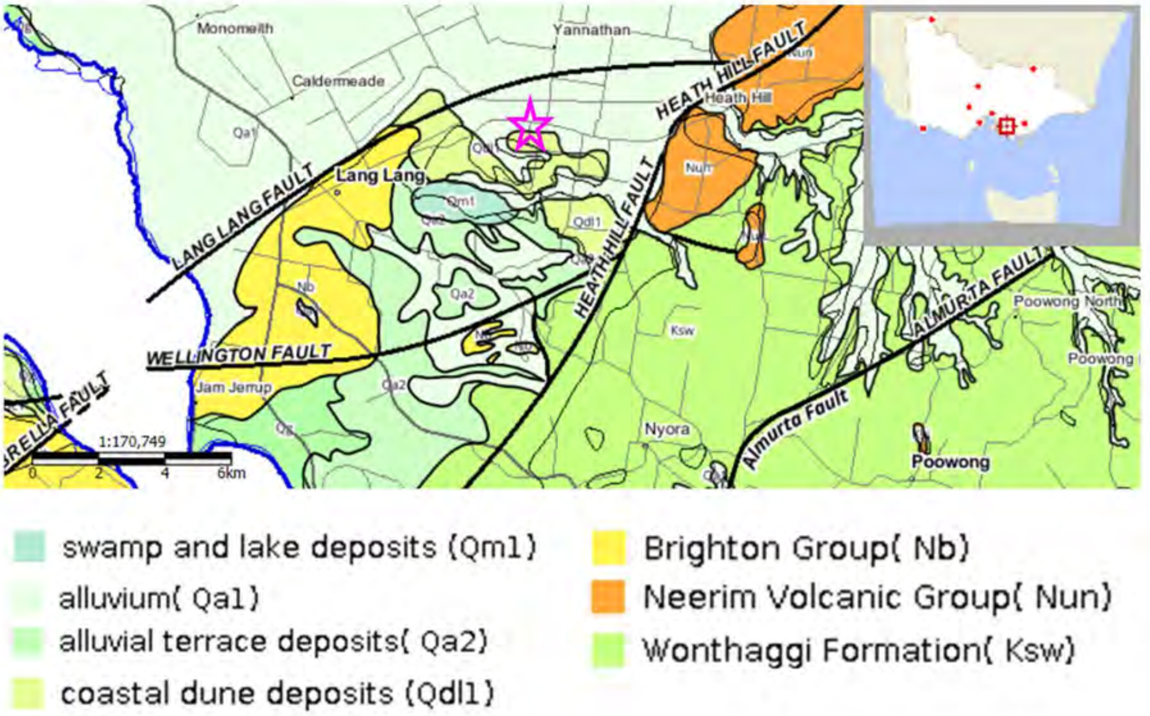

Figure 2: Local geology in the project area (star) with geological structures (GeoVic https://gsv.vic.gov.au/).

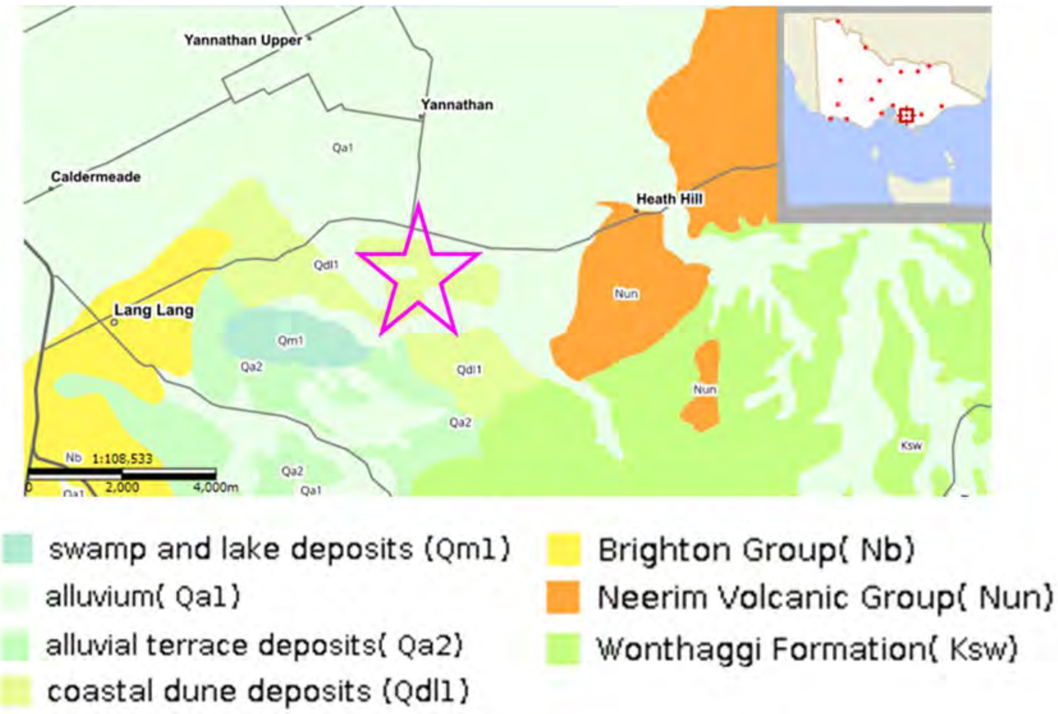

Figure 3: Local geology in the project area (GeoVic https://gsv.vic.gov.au/).

2.2 Groundwater

Visualising Victoria's Groundwater online database indicates that the water table at site is less than 5 m below ground level. This water table depth is consistent with the findings of the report prepared by Groundwater Solutions (GWS 2021).

The impact of groundwater on geotechnical stability includes consideration of the absolute water level at specific stages of excavation. Modelling has been conducted on selected water levels without investigation of the impact of rates of change of water levels. I.e., the transient/rate of change of water levels has not been considered in this assessment. We consider this a reasonable approach given the proposed method of operation ie, dredged ponds not requiring rapid water level changes and a large area of ponds providing a buffer to rapid water level change.

2.3 Adjacent Operation

2.3.1 General Site Location and Description

The site is accessed from Westernport Road east of the township of Lang Lang and south of the village of Yannathan. An earth bund covered by grass is present along the southern side of Westernport Road providing a visual screen to the site. The operational buildings and plant are located approximately 200m south of the entrance point at 870-910 Westernport Road.

2.3.2 Adjacent Operation Description

Current excavation areas are referred to as the east pit and west pit. The waterway which formerly flowed through the eastern part of the site has been diverted to the east and north. Excavation is taking place to a depth of +9m RL. Previously, the exposed sand face was observed to be approximately 200m long with clay buttressing being placed along the southern wall and on the northern wall of the east pit.

CMW understands that clay buttressing has been used at the site throughout much of its operational history. The inter-related purposes of the clay buttressing include the following:

- Optimising handling of clay overburden
- Maintaining stability of slopes
- Reducing ingress of groundwater
- Establishing slopes for rehabilitation

Areas in the central southern part of the site have been partially rehabilitated.

The processing plant is centrally located in the site, south of the access road leading from Westernport Road. Fine materials from sand processing are reduced in water content by filter pressing. The resulting filter cake are transported by conveyor to on-site disposal sites which are typically previously excavated pits. Pits which have previously been used to dispose of filter cake are located south of the processing plant and are being revegetated. No material was being placed into active pits at the time of the siteworks due to maintenance works on the processing plant.

During the CPT study it was observed that there was a temporary trench running northeast to southwest from the processing plant towards the northeast corner of the west pit as part of upgrades and/or maintenance on the processing plant.

Organic sand is being extracted from excavations to the west of the site. The western boundary of these pits along Milners Road have been battered with clay buttressing and have become grassed.

Observations and client descriptions indicate that the principal method of extraction in each of the pits has been by mechanical excavation. This has comprised excavator and dump trucks with sectional stripping under dry conditions (i.e. above the water table).

Field photographs taken during the previous site walk (2022) and CPT site works (2023) are presented in Appendix A1 and Appendix A2 respectively.

2.4 Proposed Expansion Area

CMW understand that Hanson intend to expand the extraction operation to the northern part of the site as generally illustrated in Figure 4. A sand resource similar to that previously extracted in the southern part of the area, has been identified in the proposed expansion area. The existing waterway will be realigned to the northern edge of the area during the proposed sand extraction.

Figure 4: (Upper) Indicative arrangement of the proposed expansion area (orange). (Lower) Site photograph taken from the southwest (viewed northeast across the area of the upper photograph)

2.4.1 Surrounding Areas

The proposed quarry is north and northwest of an existing operation area and is bounded at its northern-most extent by Westernport Road. The surrounding area comprises a poultry farm to the west, market garden to the north and a cattery/kennels to the east.

2.4.2 Seismicity

The peak ground acceleration increases toward the southeast in the Westernport area (Figure 5). The peak ground acceleration is indicated as a 10% chance of exceedance in 50 years equivalent to a 1 in 500 annual exceedance probability (AEP). The 1 in 500 AEP is defined in the National Construction Code. According to https://earthquakes.ga.gov.au, peak ground acceleration at the project location is between 0.05g and 0.06g. A value of 0.055g was adopted for our stability analysis of batters at the site.

The Geoscience Australia analysis of the distribution of peak ground acceleration (PGA) from the 22 September 2021 Magnitude 5.9 Mansfield earthquake showed that the Yannathan area experienced a PGA of approximately 0.04g. This is approximately 70% of the acceleration of the 1:500 year case outlined above. CMW understand no significant ground deformation was observed due to the Mansfield earthquake.

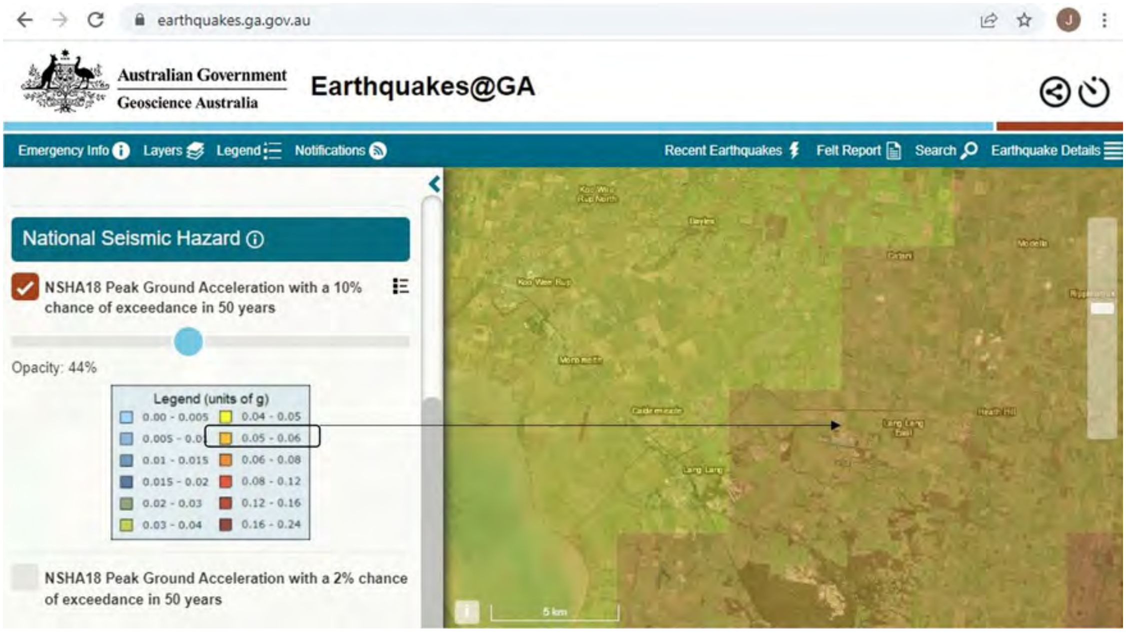

Figure 5: Seismic classification of the site location (https://earthquakes.ga.gov.au/)

According to ANCOLD (2012, 2019) guidelines on tailings dams seismic analyses are primarily based on an 'operating basis earthquake' (OBE) and a 'safety evaluation earthquake' (SEE). The SEE was defined in ANCOLD (2019) as an update of the previous terminology 'maximum credible earthquake' (MCE) defined in ANCOLD (2012). The peal ground accelerations to be considered for the OBE and SEE vary according to the consequence category as will be outlined below.

However, in many cases the peak ground acceleration for OBE is equivalent to a 10% chance of exceedance in 50 years, i.e. equivalent to a 1 in 500 annual exceedance probability (AEP). Similarly, in many cases the peak ground acceleration for SEE is equivalent to a 2% chance of exceedance in 50 years, i.e. equivalent to a 1 in 2500 annual exceedance probability (AEP). According to https://earthquakes.ga.gov.au, peak ground acceleration with 1 in 2500 AEP at the project location is approximately 0.16g. According to ANCOLD (2012, 2019), "post-closure" conditions of embankments/impoundments should be assessed for stability under the effects of the SEE.

3 DESKTOP APPRAISAL

3.1 Geology

Geological logs from the proposed expansion area show a consistent stratigraphy with a degree of variability typical in a sedimentary environment. Borehole LL13 is located in the north-western corner of the site. Boreholes YA0901-YA1907 are located through the expansion area.

Figure 6 shows a geological interpretation based on the geological descriptions in the logs. Boreholes have been projected to sections A-A' and B-B' as shown on Figure 6. This geological interpretation is based on data provided and illustrates the anticipated conditions. It is not intended to be used for resource estimation.

The locally intermittent/discontinuous nature of the layering is supported by observations of the organic sand layer in the west pit. The material strength characteristics of the pale coloured and dark coloured (organic) sands do not appear to be significantly different. This was observed by the similarity of the slope faces where these materials were both exposed and by tactile observations of the materials at the site.

A simplified ground model comprising a near-surface clay layer, an upper sand layer, organic sand layer and lower sand layer was used for hydrogeological modelling (GWS 2021).

We note lignite was reported in four boreholes in the southeast of the site but were not reported in the expansion area. Therefore, the dark coloured sands in the expansion area have been modelled according to data obtained for similar sands investigated at the Lang Lang sand quarry approximately 5 km to the southwest.

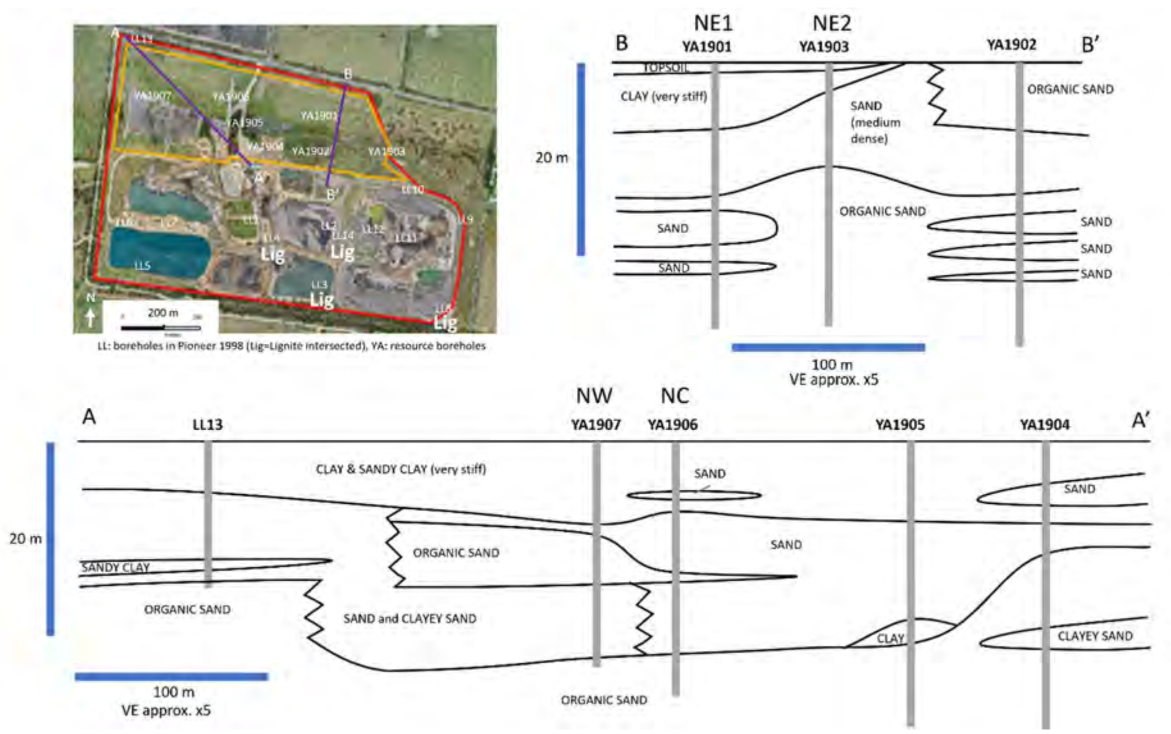

Figure 6: Illustrative geological cross-sections through the expansion area, based on data received.

3.2 Material Properties in Other Reports

3.2.1 Clay

A previous geotechnical report for the site (Chadwick 2003) reported shear vane test values in clays. These tests of clay samples from within 1.6m of the ground surface gave a shear strength of 130kPa.

A previous geotechnical study of the site (GHD 2013) assigned properties of 5 kPa effective cohesion and 28^{o} effective friction angle to the clay overburden at the site.

3.2.2 Sand (Sandringham Sandstone)

The initial material properties used in this study are derived from previous investigations in the area. Standard Penetration Testing (SPT) is a method of measurement of material density during drilling which can be used to estimate material strength. SPT data (Figure 7) was recorded for boreholes LL1 and LL2 which are located in the north-central part of the existing operation, therefore, at the southern end of expansion area (Dames and Moore 1999).

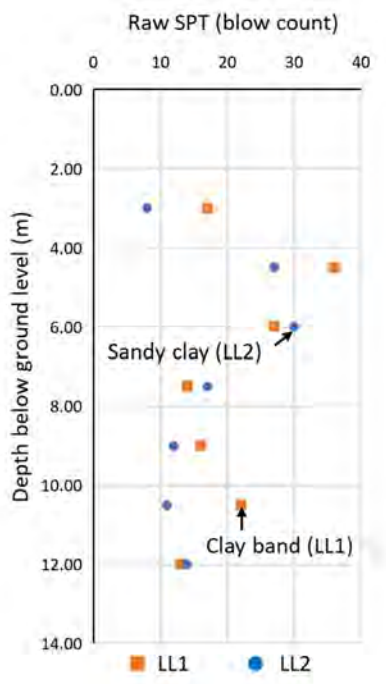

Figure 7: SPT data from previous investigation reviewed.

3.2.3 Data on Organic Sand from Lang Lang Quarry

Data on organic sand strength was obtained from a site investigation on land to the north of Hanson's existing Lang Lang quarry. Lang Lang quarry is located approximately 5 km south-southwest from the Yannathan quarry. The report from that investigation is included as Appendix B6 in this report.

The author of this report conducted the investigation at Lang Lang quarry and observed the material. The material is similar in appearance and general behaviour to dark coloured sands observed at Yannathan (e.g. Figure 8).

A range of terms have been used to describe and/or name the dark coloured sands observed in the sedimentary sequence in the region. The term organic sand has been adopted here to describe the dark coloured sands which appear well sorted with low fines content and mainly soluble humic compounds providing the dark colour (Table 4).

Table 4: Terminology Related to Sand Types	
Terminology used herein	Other related terms
Organic sand	Black sand, Carbonaceous sand, Humic sand
Sand	Clean sand

Notes:

In general 'black sand' can be formed from accumulations of dark coloured minerals (eg eroded basalts in Hawaii) or accumulations of dark coloured heavy minerals. While the term is descriptive it may be too general for the materials observed at Yannathan.

Carbonaceous sand could imply that particles of lignite etc are present in the sand.

Humic sand is a technical term referring to the result of migration of humic compounds in ground water to coat the individual grains resulting in a dark coloured sand (Swanson and Palacas 1965).

Clean sand is not used in the sense of absence of organic matter as the term clean sand is defined in terms of the presence of fine particles.

Lignite/Coal was observed at the following depths in four boreholes in the southeast corner of the existing quarry area (Pioneer Concrete 1998). LL3 coal at 13m, LL4 coal at 15m, LL8 coal at 13.5m, LL14 coal at 11m (Annotated 'C' on Figure 6). The black/dark sands in the expansion area are inferred to be non-lignite bearing and to be similar to those observed in the west pit (Figure 8).

Figure 8: Organic sand exposure (approximately 2 m thickness visible) at Yannathan

The material described as organic sand and other types of black or dark coloured sand in the logs at Yannathan are inferred to be similar to the material observed at the Lang Lang quarry.

The details of the investigation at Lang Lang are in Appendix B6. In summary samples of core were derived from PQ size (approx. 80 mm) drilling between 15 m and 31 m below surface. The retrieved core was organic sand. Four samples of organic sand were tested for strength by the consolidated undrained triaxial test. The particle size was also determined by sieving. Of the four tests the effective (drained) cohesion ranged from 5.8 to 26.6 kPa and the effective (drained) friction angle ranged from 35.2 to 39.4^{o}. The particle size distribution showed the sand to be at the low end of the medium sand size range very low fines content.

3.3 Extraction Sequence

CMW understand that the intention of Hanson is to extract sand in the northern part of the expansion area to facilitate the formation of the waterway diversion. Therefore, the initial extraction of sand would need to be conducted without impact on the existing waterway. The slope on the northern (adjacent to property boundary) and southern (adjacent to existing waterway) sides of the initial excavation are expected to be the same based on material type and anticipated groundwater conditions.

The initial extraction of sand prior to diversion of the waterway will be limited by the requirement to maintain a buffer zone from the existing waterway. A buffer of 20m is understood to be the requirement of the existing work plan approval.

The distance between the waterway and the northern boundary of the site increases toward the centre of the extraction area northern boundary. Therefore, if an excavation slope gradient of 1:3 (V:H) were applied as an example then a slope from 25m to 9m elevation would require approximately 50 m of horizontal extent on each face (north and south). Therefore, initial excavation depth may be limited by this restriction at the north-western end and eastern end of the extraction zone where the existing waterway is closest to the northern property boundary.

The initial excavation at the northern perimeter of the site is not a final slope as it is intended to be buttressed by clay fill as overburden is extracted elsewhere on the site. According to the ERR definition, a terminal slope is defined as “The final (as-designed or as-built) operational pit slope” (ERR 2020). For the purpose of this assessment, the excavation adjacent to the boundary is considered as a terminal slope even though it is exposed temporarily before the placement of the clay buttress. The buttressed slope is the final slope and represents the rehabilitation profile at the perimeter of the excavation.

The initial excavation of sand on the northern boundary of the area is limited in depth by the presence of the existing waterway. The initial extraction of sand will only occur to a depth that allows an adequate stability buffer with the waterway – a depth that will vary from shallower in the west to deeper in the east as the distance between the waterway and northern boundary increases.

The full depth excavation to -9 mRL after the buttress is emplaced and the waterway diversion has been constructed, is a terminal face under the ERR definition. The deeper part of the excavation will be conducted by dredging.

4 FIELD INVESTIGATION

A field investigation by CMW was carried out between 11 January and 13 January 2023. Subcontractor Insitu Geotech Services (IGS) were engaged to complete 13 no. CPTu probes under the direction of a CMW geotechnical engineer who was responsible for positioning of tests and supervision of fieldwork. All fieldwork was carried out in general accordance with AS1726 (2017), Geotechnical Site Investigations. The scope of fieldwork completed was as follows:

- Undertake a walkover survey of the site to assess the general landform, site conditions and adjacent in structures / infrastructure
- Advance thirteen (13) x Cone Penetration Tests (CPTu) with pore water measurement to assess density/compaction of clay batters, filter cake disposal areas and proposed sand resources

Additional fieldwork completed on site, utilised in this report includes.

- Three (3) x Dynamic Probing Super Heavy (DPSH) to target depth or prior refusal
- Nine (9) x Dynamic Cone Penetrometer (DCP) to 3.3 m or prior refusal

Photos of the siteworks and general observations can be seen in Appendix A2.

CPT Test results as provided by IGS and CMW's internal analysis of CPT data are presented in Appendices B1 and B2. Liquefaction analysis results are presented in Appendix B3. DPSH plots showing the of number of blows per 100mm advance (N10) and cone resistance (qd) against depth and DCP results are provided in Appendix B4 and Appendix B5 respectively.

Table 5 summarises the number and type of tests conducted in each of the general locations. CPT, DPSH and DCP test locations are presented in Appendix A3. CPT locations were provided by the CPT operators.

Table 5: Test location and type		
General Location (identified as Areas 1-4 for this investigation)	**Test Type**	**No. of Tests Completed**
Western area of previously constructed clay batter (Area 1) *	CPT	3
	DPSH	1
Western area of previously constructed clay batter (land bridge) (Area 1) *	CPT	1
	DPSH	2
	DCP	3
Proposed expansion area north bund (Area 2)	CPT	5
Proposed expansion area adjacent to southern bund (Area 2)	CPT	2
Previous filter cake disposal areas (Area 3) *	CPT	1
	DCP	6
Eastern area haul road (Area 4) *	CPT	1
Note *: Locations outside the proposed expansion area		

4.1 Subsurface Conditions and Site Observations

Interpretation of the CPT investigation results suggest the ground conditions present on site are generally consistent with the published geology of the area.

The material descriptions related to CPT data are based on the soil behaviour type (SBT). The behaviour type descriptions/names used do not necessarily correspond to the material types as defined by geological logging (Robertson 2016).

The ground conditions may be summarised in Tables 6 through to Table 11 below. Refer to Appendix B2 for individual geotechnical profiles.

CPTu probes in the western area of the previously constructed clay batter generally met refusal in dense sand which was overlain by clay / silty clay material.

Surface RL values have been estimated from the contour maps in Appendix A3. Figures 9, 10, 11, 12 and 13 below present the location of the CPTu probes. Refer to Appendix A3 for site plans.

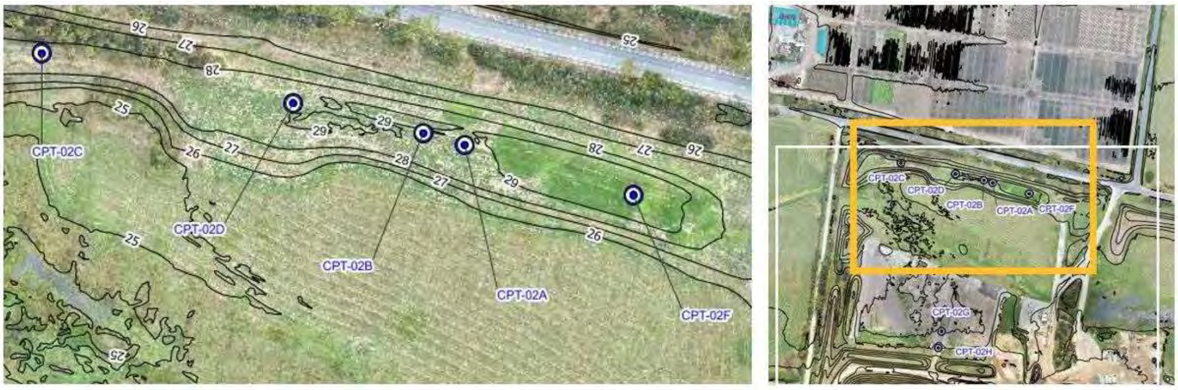

Figure 9: CPTu locations - proposed expansion area northern bund

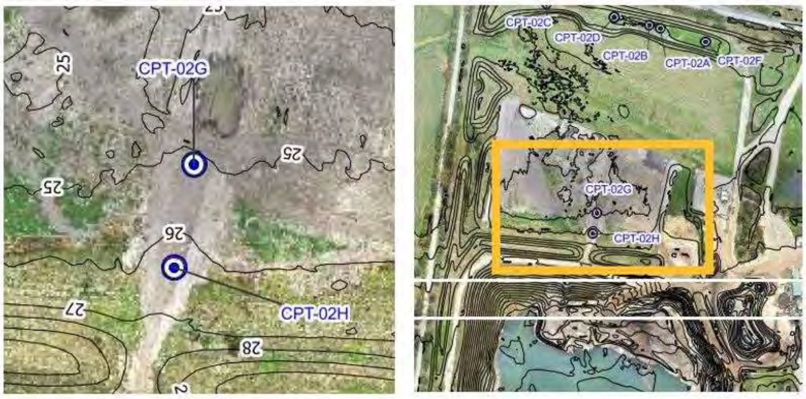

Figure 10: CPTu locations - proposed expansion area adjacent to southern bund

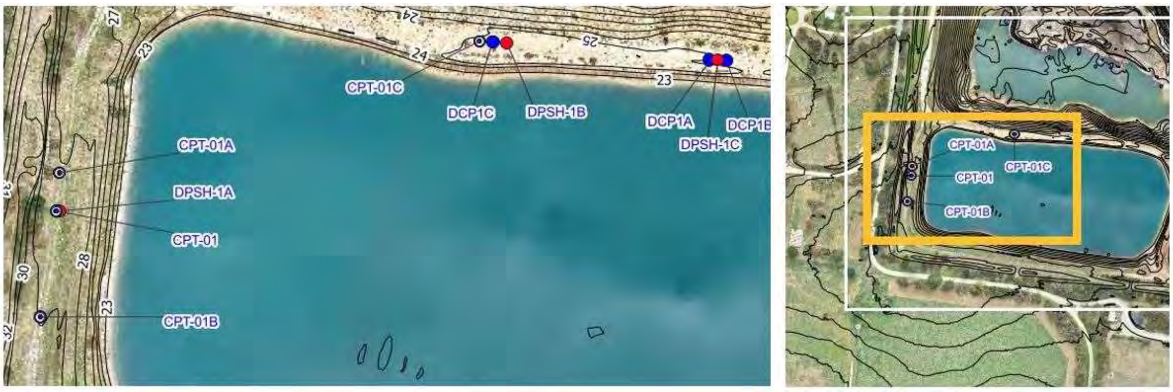

Figure 11: CPTu locations - western area of previously constructed clay batter including landbridge

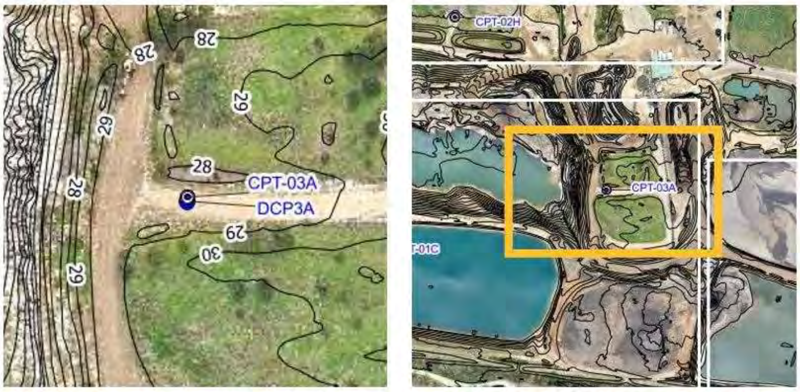

Figure 12: CPTu locations - previous filter cake disposal area

Figure 13: CPTu locations - eastern area haul road

Table 6: Sub-surface conditions - western area of previously constructed clay batter			
Unit	**Depth to Base of unit (mbgl)**		
	CPT-01	CPT-01A	CPT-01B
Surface elevation (mRL)	28.1	28.0	29.0
Sand & Silty Sand / Silty Sand and Sandy Silt	2.75	2.40	2.39
Statistical data*	(4.91, 2.32; 1.61, 1.25)	(4.35, 2.22; 0.82, 0.5)	(6.35, 3.70; 1.04, 0.51)
Clay / Clay & Silty Clay	3.68	3.15	4.46
Statistical data*	(2.52, 0.95; 6.64, 5.53)	(2.96, 1.10; 5.03, 2.12)	(2.11, 0.78; 6.25, 1.51)
Sand	3.77	4.03	4.70
Statistical data*	(46.30, 13.59; NA, NA)	(46.91, 8.67; 0.63, 0.14)	(47.69, 17.49; 0.35, 0.15)
Note *: Average and standard deviation of cone resistance and friction ratio values are in brackets (Av q_c, SD q_c; Av FR, SD FR)			

The land bridge running east to west through the western pit generally comprised of soft clay to 10.29 m which overlies sand / silty sand which is present until the termination depth of 12.30 m.

Table 7: Sub-surface conditions - western area of previously constructed clay batter (land bridge)	
Unit	**Depth to Base of unit (mbgl)**
	CPT-01C
Surface elevation (mRL)	25.0
Clay & Silty Clay / Clay	8.90
Statistical data*	(1.68, 0.94; 6.19, 1.97)
Silty Sand & Sandy Silt	9.56
Statistical data*	(3.85, 1.31; 1.83, 0.78)
Clay	10.29
Statistical data*	(0.92, 0.33; 6.82, 2.75)
Sand & Silty Sand	12.30
Statistical data*	(41.42, 17.85; 0.53, 0.21)
Note *: Average and standard deviation of cone resistance and friction ratio values are in brackets (Av q_c, SD q_c; Av FR, SD FR)	

CPTu probes were conducted through the northern bund which forms the boundary between the proposed quarry extension and Westernport Rd. SBT results suggest the bund and subsurface comprises interbedded layers of sand / silty sand / sandy silt and clay / silty clay to approximately 12.2 – 13.0 m, after which a very dense sand layer commences.

Table 8: Sub-surface conditions - proposed expansion area north bund					
Unit	**Depth to Base of unit (mbgl)**				
	CPT-02A	CPT-02B	CPT-02C	CPT-02D	CPT-02F
Surface elevation (mRL)	29.0	28.9	28.3	29.0	29.2
Sand & Silty Sand / Silty Sand & Sandy Silt (bund)	-	-	2.12	-	0.63
Statistical data*			(7.40, 3.45; 0.91, 0.54)		(3.74, 2.03; 0.72, 0.07)
Clay & Silty Clay (bund)	0.92	1.00	2.76	-	1.45
Statistical data*	(1.40, 1.04; 1.60, 1.01)	(1.59, 1.27; 1.82, 1.19)	(8.61, 0.47; 1.58, 0.31)		(0.83, 0.15; 2.26, 1.41)
Sand & Silty Sand / Silty Sand & Sandy Silt (bund)	2.78	4.77	4.29	4.09	4.33
Statistical data*	(7.57, 3.44; 1.52, 0.86)	(3.95, 3.26; 2.66, 1.17)	(11.18, 9.78; 1.34, 0.90)	(6.31, 4.60; 1.61, 0.66)	(11.97, 10.04; 1.52, 0.68)
Clay & Silty Clay	4.89	6.89	5.21	6.99	8.38
Statistical data*	(2.14, 0.83; 2.82, 1.33)	(1.57, 0.23; 2.48, 0.69)	(1.59, 0.47; 3.77, 0.62)	(1.65, 0.67; 2.77, 0.73)	(1.98, 0.62; 3.11, 0.99)
Sand & Silty Sand / Silty Sand & Sandy Silt	10.35	9.21	11.34	10.45	11.17
Statistical data*	(12.90, 6.10; 1.25, 0.92)	(5.17, 3.65; 2.33, 1.23)	(5.72, 3.01; 1.49, 0.91)	(6.4, 6.67; 1.69, 0.88)	(11.96, 6.25; 1.18, 0.63)
Clay & Silty Clay / Clay	12.21	12.60	13.07	12.54	12.31
Statistical data*	(3.31, 1.14;	(3.39, 2.48;	(2.05, 0.87;	(2.31, 0.97;	(3.72, 0.79;

Table 8: Sub-surface conditions - proposed expansion area north bund					
Unit	**Depth to Base of unit (mbgl)**				
	CPT-02A	CPT-02B	CPT-02C	CPT-02D	CPT-02F
	3.30, 0.75)	3.78, 1.69)	2.19, 0.78)	2.59, 0.69)	4.56, 1.41)
Sand / Silty Sand & Sandy Silt	12.84	13.71	14.12	13.16	13.12
Statistical data*	(41.36, 12.04; 0.48, 0.12)	(13.78, 14.36; 0.44, 0.25)	(9.32, 16.24; 2.47, 1.58)	(16.2, 20.33; 2.67, 1.40)	(38.03, 15.44; 0.46, 0.17)
Note *: Average and standard deviation of cone resistance and friction ratio values are in brackets (Av q_c, SD q_c; Av FR, SD FR)					

Two probes were conducted within the boundary of the proposed quarry expansion. CPT-02G and CPT-02H were located approximately 30 and 10 m north from the southern bund, respectively. The test at CPT-02G shows the subsurface to comprise primarily of silty sand / sandy silt to 8.45 m with two thin (0.6 – 1.2 m) bands of fine grained clay / silty clay material. Analysis CPT-02H, which was conducted closer to the south bund suggest the clay bands could be thicker toward the south. Tests refused in very dense sand / silty sand layer, similar to that which was observed along the northern bund.

The thickness of clay overburden is approximately 8 m in the areas tested. Based on initial calculations an area of 300 m by 600 m would have an adequate volume of overburden to construct perimeter batters of the dimensions described in this report.

Table 9: Sub-surface conditions - proposed expansion area adjacent to south bund		
Unit	**Depth to Base of unit (mbgl)**	
	CPT-02G	CPT-02H
Surface elevation (mRL)	0.58	1.22
Sand & Silty Sand / Silty Sand & Sandy Silt	1.81	2.86
Statistical data*	(6.06, 3.23; 1.40, 0.87)	(5.72, 3.86; 1.67, 1.05)
Clay & Silty Clay	7.20	6.63
Statistical data*	(1.55, 0.62; 2.13, 0.46)	(1.72, 0.24; 3.57, 0.85)
Silty Sand & Sandy Silt	7.81	10.22
Statistical data*	(3.15, 1.02; 2.47, 0.67)	(3.77, 1.19; 2.28, 0.47)
Clay & Silty Clay	8.45	10.45
Statistical data*	(4.60, 0.96; 5.28, 1.19)	(4.17, 1.69; 4.23, 1.64)
Sand & Silty Sand	0.58	1.22
Statistical data*	(14.71, 16.48; 1.15. 1.06)	(36.76, 17.94; 0.88, 0.45)
Note *: Average and standard deviation of cone resistance and friction ratio values are in brackets (Av q_c, SD q_c; Av FR, SD FR)		

One CPTu was conducted on the western road adjacent to the former filter cake disposal pit. During testing CPT operators reported very soft ground conditions from approximately 1.5 mbgl. SBT analysis indicates very soft material is present from 1.6 – 7.3 mbgl, which is underlain by soft to very soft material. The transition through the very soft to soft material is continuous through the materials. CPT operators recommended terminating the test once a hard layer was encountered at 17.53 m due to excessive deflection of probe rods in the soft upper material.

Table 10: Sub-surface conditions – previous filter cake disposal areas	
Unit	**Depth to Base of unit (mbgl)**
	CPT-03A
Surface elevation (mRL)	28.5
Clay cover	1.61
Statistical data*	(1.47, 0.99; 4.04, 0.82)
Upper Clay / Silt	7.31
Statistical data*	(0.21, 0.03; 4.77, 0.59)
Lower Clay / Silt	16.91
Statistical data*	(0.51, 0.22; 3.85, 0.90)
Sand / Sand & Silty Sand (inferred natural ground)	17.53
Statistical data*	(20.15, 7.49; 0.37, 0.09)
Note *: Average and standard deviation of cone resistance and friction ratio values are in brackets (Av q_c, SD q_c; Av FR, SD FR)	

Due to access constraints and boggy conditions in areas close to the eastern pit, 1 no. probe was carried out on the haul road leading to the eastern clay batters. Encountered material has been classified as interbedded sands / silty sands with hard clay layers using SBT analysis.

Table 11: Sub-surface conditions – eastern area haul road

Unit	Depth to Base of unit (mbgl)
	CPT-04A
Surface elevation (mRL)	20.5
Silty Sandy & Sandy Silt	0.64
Statistical data*	(1.39, 0.42; 0.58, 0.26)
Clay	3.98
Statistical data*	(0.81, 0.47; 4.29, 2.08)
Very Dense / Stiff Clay	6.14
Statistical data*	(6.08, 2.38; 5.41, 2.39)
Silty Sand & Sandy Silt / Sand & Silty Sand	19.34
Statistical data*	(13.33, 8.12; 0.91, 1.06)
Clay & Silty Clay	27.82
Statistical data*	(5.95, 2.06; 2.85, 1.44)
Note *: Average and standard deviation of cone resistance and friction ratio values are in brackets (Av q_c, SD q_c; Av FR, SD FR)	

5 INVESTIGATION RESULTS

5.1 CPTu – Estimated Material Properties

Estimated material properties obtained from analysis of CPTu data are summarised in Tables 12 to 17. Refer to Appendix B2 for comprehensive sets of parameters determined using CPeT-iT analysis software. Drained (effective) properties of clay materials are based on CMW experience with similar materials.

Table 12: Estimated material properties - western area of previously constructed clay batter

Material Behaviour Type	Unit weight (kN/m³)		Undrained Shear Strength (kPa)		Effective cohesion (kPa)		Effective friction angle (degrees)	
	Average	Range	Average	Range	Average	Range	Average	Range
Sand & Silty Sand / Silty Sand and Sandy Silt	18.2	17.1 – 18.9	N/A	N/A	N/A	N/A	37.5	33.2 – 40.9
Clay / Clay & Silty Clay *	19.0	18.8 – 19.1	163.7	127.7 – 230.9	10	-	28	-
Sand	20.0	20.0 – 21.3	N/A	N/A	N/A	N/A	48.6	47.1 – 51.2

Note *Drained clay properties are those adopted after review of the undrained testing overall.

N/A not applicable material property for the material type

I/D insufficient data to undertake meaningful statistics

Table 13: Estimated material properties - western area of previously constructed clay batter (land bridge)								
Material Behaviour Type	**Unit weight (kN/m³)**		**Undrained Shear Strength (kPa)**		**Effective cohesion (kPa)**		**Effective friction angle (degrees)**	
	Average	Range	Average	Range	Average	Range	Average	Range
Clay & Silty Clay / Clay	18.3	17.5 – 18.9	102.9	83.6 – 127.1	10	-	28	-
Silty Sand & Sandy Silt	18.2	I/D	N/A	N/A	N/A	N/A	35.8	I/D
Clay	17.6	I/D	47.1	I/D	10	-	28	-
Sand & Silty Sand	20.7	20.2 – 21.2	N/A	N/A	N/A	N/A	47	45.3 – 48.7
Note *: Drained clay properties are those adopted after review of the undrained testing overall. N/A not applicable material property for the material type I/D insufficient data to undertake meaningful statistics								

Table 14: Estimated material properties - proposed expansion area north bund								
Material Behaviour Type	**Unit weight (kN/m³)**		**Undrained Shear Strength (kPa)**		**Effective cohesion (kPa)**		**Effective friction angle (degrees)**	
	Average	Range	Average	Range	Average	Range	Average	Range
Sand & Silty Sand / Silty Sand & Sandy Silt (bund)	17.6	17.0 – 18.2	N/A	N/A	N/A	N/A	36.7	35.2 – 38.3
Clay & Silty Clay (bund)	16.5	16.1 – 17.6	75.6	54.0 – 126.4	10	-	28	-
Sand & Silty Sand / Silty Sand & Sandy Silt (bund)	18.7	17.5 – 19.9	N/A	N/A	N/A	N/A	39.5	36.4 – 43.2
Clay & Silty Clay	17.7	16.8 – 18.2	108.5	62.7 – 148.7	10	-	28	-
Sand & Silty Sand / Silty Sand & Sandy Silt	18.8	17.5 – 19.5	N/A	N/A	N/A	N/A	38.6	34.8 – 41.8
Clay & Silty Clay / Clay	18.4	17.6 – 19.3	177.7	114.8 – 228.4	10	-	28	-
Sand / Silty Sand & Sandy Silt	20.3	19.7 – 21.1	N/A	N/A	N/A	N/A	45.8	43.1 – 48.3

Note *: Drained clay properties are those adopted after review of the undrained testing overall.

N/A not applicable material property for the material type

I/D insufficient data to undertake meaningful statistics

Table 15: Estimated material properties - proposed expansion area adjacent to south bund								
Material Behaviour Type	**Unit weight (kN/m³)**		**Undrained Shear Strength (kPa)**		**Effective cohesion (kPa)**		**Effective friction angle (degrees)**	
	Average	Range	Average	Range	Average	Range	Average	Range
Sand & Silty Sand / Silty Sand & Sandy Silt	18.2	18.2 – 18.3	N/A	N/A	N/A	N/A	38.4	37.8 – 39.1
Clay & Silty Clay	17.5	17.1 – 17.9	103.7	91.8 – 115.6	10	-	28	-
Silty Sand & Sandy Silt	18.3	17.6 – 19.1	N/A	N/A	N/A	N/A	37.5	36.1 – 40
Clay & Silty Clay	19.4	18.4 – 19.9	254.5	182.5 – 293.2	10	-	28	-
Sand & Silty Sand	19.1	18.4 – 20.3	N/A	N/A	N/A	N/A	51.4	44.9 – 55.6

Note *: Drained clay properties are those adopted after review of the undrained testing overall.

N/A not applicable material property for the material type

I/D insufficient data to undertake meaningful statistics

Table 16: Estimated material properties - previous filter cake disposal areas								
Material Behaviour Type	**Unit weight (kN/m^3)**		**Undrained Shear Strength (kPa)**		**Effective cohesion (kPa)**		**Effective friction angle (degrees)**	
	Average	Range	Average	Range	Average	Range	Average	Range
Clay cover	17.5	I/D	73.7	I/D	-	-	-	-
Upper Clay / Silt	15.1	15 – 15.3	10.4	N/A	-	-	-	-
Lower Clay / Silt	16.1	15.7 – 16.8	26.0	N/A	3	-	22	-
Sand / Sand & Silty Sand	19.2	18.8 – 19.7	N/A	N/A	N/A	N/A	41.6	39.7 – 43.6
Note *: Drained clay properties are those adopted after review of the undrained testing overall. N/A not applicable material property for the material type I/D insufficient data to undertake meaningful statistics								

Table 17: Estimated material properties - eastern area haul road								
Material Behaviour Type	**Unit weight (kN/m^3)**		**Undrained Shear Strength (kPa)**		**Effective cohesion (kPa)**		**Effective friction angle (degrees)**	
	Average	Range	Average	Range	Average	Range	Average	Range
Silty Sandy & Sandy Silt	15.4	I/D	N/A	N/A	N/A	N/A	32.1	N/A
Clay	16.0	15.3 – 16.8	37.5	N/A	3	-	22	-
Very Dense / Stiff Clay	20.3	N/A	417.7	N/A	15	-	30	-
Silty Sand & Sandy Silt / Sand & Silty Sand	18.4	18 - 19	N/A	N/A	N/A	N/A	37.9	34 – 41
Clay & Silty Clay	19.3	19.3 – 19.4	474.3	N/A	15	-	30	-
Note *: Drained clay properties are those adopted after review of the undrained testing overall. N/A not applicable material property for the material type I/D insufficient data to undertake meaningful statistics								

Generalised properties for made ground (batters) and natural material are summarised in Figure 14 and Table 18 below. These values were adopted in the slope stability assessments described in Section 6. The adopted parameters for organic sand have been derived from a recent study at Lang Lang by CMW for Hanson. The details of that study are included as Appendix B6 in this report.

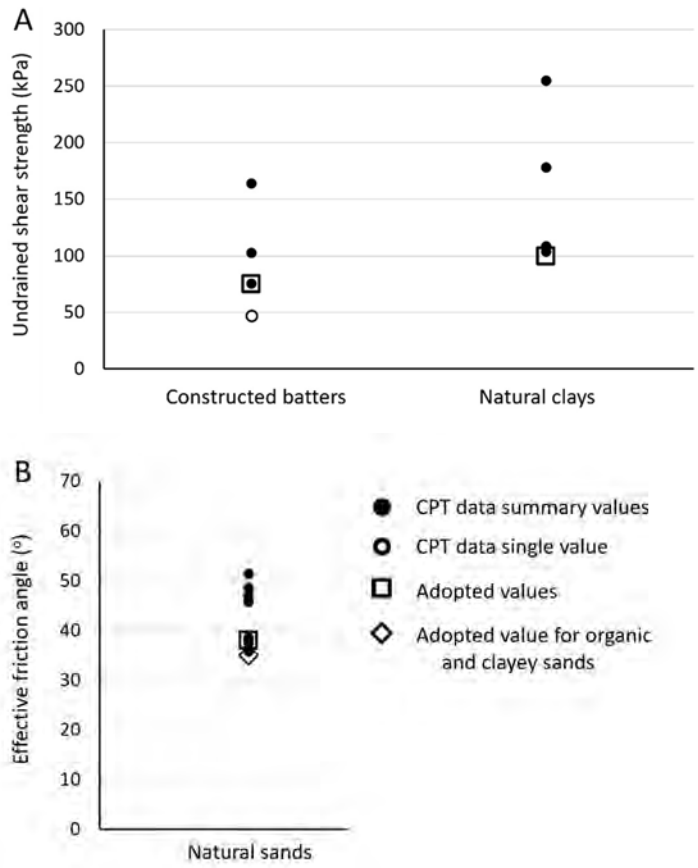

Figure 14: Graphical summary of CPT-derived values and adopted values for the proposed expansion area for A) undrained shear strength in intervals identified by CPT as clayey behaviour and B) effective friction angle for intervals identified by CPT as sandy behaviour.

Table 18: Generalised material properties					
Material Nature	**Material Description**	**Unit Weight (kN/m^3)**	**Undrained Shear Strength (kPa)**	**Effective cohesion (kPa)**	**Effective friction angle (degrees)**
Constructed batters	Clay / Silty Clay	17.0	75	6	26
	Sand / Silty Sand	18.0	N/A	0	36
Natural ground	Clay / Silty Clay	19.0	100	10	28
	Sand / Silty Sand	19.0	N/A	0	38
	Clayey Sand	19.0	N/A	3	35
	Organic Sand	19.0	N/A	3	35

5.2 CLiq Analysis Results

CPT profiles were analysed using CLiq, a soil liquefaction analysis software developed by geotechnical engineering software developer Geologismiki. Results of the liquefaction analysis, as presented in Appendix B3, shows that soils at all tested locations are at a low risk of liquefying during a seismic event. The analysis considered a seismic event with peak ground acceleration (PGA) of 0.24g, far exceeding the 1 in 500 AEP peak (0.055g) adopted for slope stability analyses described in Section 6.

5.3 DPSH Results

A summary of the dynamic cone resistance (qd) by depth is summarised in Table 19 and a summary of N(10) values by depth is summarised in Table 20. DPSH-01A and DPSH-01B were conducted Complete DPSH results are presented in appendix B4.

Table 19: Summary of typical resistance (qd) and maximum resistance (qd) over depth at DPSH location 1A to 1C

	DPSH-01A		DPSH-01B		DPSH-01C	
Elevation (mRL)	**Typical qd (MPa)**	**Maximum qd (MPa)**	**Typical qd (MPa)**	**Maximum qd (MPa)**	**Typical qd (MPa)**	**Maximum qd (MPa)**
29.0 – 28.0	9-13	40.25	-	-	-	-
28.0 – 27.0	4-5	30.71	-	-	-	-
27.0 – 26.0	2-10	13.04	-	-	-	-
26.0 – 25.0	2-5	5.69	5-6	6.29	-	-
25.0 – 24.0	20-30	46.45	1-2	2.92	3-4	6.53
24.0 – 23.0	-	-	2-3	5.13	1-2	2.93
23.0 – 22.0	-	-	2-5	6.43	1-2	1.89
22.0 – 21.0	-	-	2-3	5.20	1-2	9.23
21.0 – 20.0	-	-	3-4	6.68	2-3	3.05
20.0 – 19.0	-	-	3-6	7.43	3-4	6.44
19.0 – 18.0	-	-	3-4	6.07	3-6	6.31
18.0 – 17.0	-	-	3-5	5.93	2-4	5.13
17.0 - 16.0	-	-	3-4	4.33	3-4	4.24
16.0 - 15.0	-	-	1-2	1.53	1-2	2.35
15.0 – 14.0	-	-	13-25	102.1	1-2	1.84
14.0 – 13.0	-	-	-	-	1-2	1.49
13.0 – 12.0	-	-	-	-	1-3	3.35
12.0 – 11.0	-	-	-	-	11-17	21.38
Note: Elevations were recorded using a hand-held GPS to the inherent accuracy of the device						

Table 20: Summary of typical N(10) values and maximum N(10) values over depth at DPSH location 1A to 1C						
	DPSH-01A		**DPSH-01B**		**DPSH-01C**	
Elevation (mRL)	**Typical N(10)**	**Maximum N(10)**	**Typical N(10)**	**Maximum N(10)**	**Typical N(10)**	**Maximum N(10)**
29.0 – 28.0	5	5	-	-	-	-
28.0 – 27.0	2-3	6	-	-	-	-
27.0 – 26.0	2-3	6	-	-	-	-
26.0 – 25.0	2-3	3	1-2	3	-	-
25.0 – 24.0	1-6	20	1-2	2	1-2	3
24.0 – 23.0	-	-	1-2	3	0-1	2
23.0 – 22.0	-	-	2-4	5	0-1	1
22.0 – 21.0	-	-	1-2	4	1-2	6
21.0 – 20.0	-	-	2-3	4	1-2	2
20.0 – 19.0	-	-	1-3	5	2-3	5
19.0 – 18.0	-	-	2-4	4	3-4	4
18.0 – 17.0	-	-	1-3	5	2-3	4
17.0 – 16.0	-	-	1-2	2	2-3	3
16.0 – 15.0	-	-	1-2	4	1-2	2
15.0 – 14.0	-	-	7-15	18	1-2	2
14.0 – 13.0	-	-	-	-	1-2	2
13.0 – 12.0	-	-	-	-	2-3	3
12.0 – 11.0	-	-	-	-	8-15	19
Note: Elevations were recorded using a hand-held GPS to the inherent accuracy of the device						

5.4 DCP Results

DCP data recorded at 3 no. locations on the land bridge within the west pit is summarised in Table 20. 6 no. locations were also tested on haul roads to the west and southeast of the former filter cake disposal pit south of the processing plant. DCP-3A which was conducted on the western side of the pit reached the target depth of 3.3 mbgl. Shallow rock was encountered on the eastern boundary of the pit, with no DCPs penetrating deeper than 0.5 mbgl. Results of DCPs which reached target depth are summarised in Table 21. Refer to Appendix B5 for complete blow counts.

Table 21: Summary of DCP results - western area of previously constructed clay batter (land bridge) and former filter cake disposal pit

	DCP-1A		DCP-1B		DCP-1C		DCP-3A	
Elevation (mRL)	**Typical blows per 100mm**	**Max. blows per 100mm**	**Typical blows per 100mm**	**Max. blows per 100mm**	**Typical blows per 100mm**	**Max. blows per 100mm**	**Typical blows per 100mm**	**Max. blows per 100mm**
29.0 – 28.0	-	-	-	-	-	-	1-2	10
28.0 – 27.0	-	-	-	-	-	-	4-6	8
27.0 - 26.0	-	-	-	-	-	-	5-7	11
26.0 – 25.0	-	-	-	-	1-3	9	8-12	12
25.0 – 24.0	1-2	8	1-3	9	2-3	3	-	-
24.0 – 23.0	2-4	10	3-4	14	6-11	15	-	-
23.0 – 22.0	3-5	14	3-7	14	17-19	22	-	-
22.0 – 21.0	7-10	14	15-16	19	-	-	-	-
Note: Elevations were recorded using a hand-held GPS to the inherent accuracy of the device								

Assuming ground conditions as determined from CPeT-iT analysis of CPT-01C are consistent across the length of the land bridge, the clay soil is Soft to Stiff from 0 – 2 mbgl before becoming Very Stiff from 2 – 3.3 mbgl. These results are in line with CPeT-iT strength estimates of clay / silty clay present from 0 – 8.90 mbgl, which estimates the material to be Stiff to Very Stiff.

Results from DCP-3A suggest the clay cover and upper clay / silt layer varies from Soft to Very Stiff from 0 – 3.3 mbgl. However, CPeT-iT analysis places the clay cover as Stiff and the upper clay / silt as Very Soft.

6 SLOPE STABILITY ASSESSMENT

6.1 Stability Acceptance Criteria

6.1.1 Static Conditions

CMW understands that the FoS against failure of the operational and terminal faces is a key criterion in confirming the stability of the quarry. In line with the requirements of the ERR document published in September 2020, we have reviewed the guidance measures presented in Guidelines of Open Pit Design, Read & Stacey, 2009 in assessing what might be an appropriate FoS.

Table 9.3 of Section 9.3.2 of Read & Stacey, provides guidelines for establishing acceptable FoS for the project setting. An adapted version of Table 9.3 is included in ERRs September 2020 document, and is presented as Figure 15.

Consequence of failure impacting on public safety, infrastructure, environment, land or property	Acceptable (Mean) FOS	Acceptable Minimum PoF
Not serious	1.3	10%
Moderately serious	1.6	1%
Very serious	2.0	0.5%

Note: Not Serious: Individual benches; small (< 50 m), temporary slopes, not adjacent to haulage roads. Moderately serious: Any slope of a permanent or semi-permanent nature. Very Serious: Medium-sized (50–100 m) and high slopes (<150 m) carrying major haulage roads or underlying permanent mine installations

Figure 15: Extract from *Geotechnical guideline for terminal and rehabilitated slopes, Extractive Industry projects'* (September 2020) – [From Table 9.3 from section 9.3.2, Read & Stacey, 2009]

6.1.2 Seismic Conditions for Excavated Faces

It is generally accepted that seismic conditions should be assessed against lower factor of safety criteria (Read and Stacey 2009). Typical static and seismic analyses acceptance values used in mining are summarised in Figure 16.

Slope	Consequence of failure	FoS (static)	FoS (dynamic/ seismic)	PoF (min)
Bench	Low–high	1.1	NA	25–50%
Inter-ramp	Low	1.15–1.2	1.0	25%
	Medium	1.2	1.0	20%
	High	1.2–1.3	1.1	10%
Overall	Low	1.2–1.3	1.0	15–20%
	Medium	1.3	1.05	5–10%
	High	1.3–1.5	1.1	≤5%

Figure 16: Extract from Read and Stacey (2009 p. 223, Table 9.9)

6.1.3 Sensitive Receptors for Excavated Slopes

CMW has considered challenges arising with the proposed terminal faces within the new extraction area would be deemed to be 'Moderately Serious'. The reasons for the selected design criteria Consequence of Failure are:

- There are no elements of critical infrastructure adjacent to the margins of the extraction area.
- It is anticipated that tension cracking and associated settlement would represent the form of deformation that could occur off-site if the geotechnical assessments have over-estimated the slope stability.
- Westernport Road is understood to be constructed of flexible pavement and would not be expected to suffer damage as a result of small amounts of settlement.

This report does not attempt to undertake a probabilistic failure analysis. It is noted that a 'Moderately serious' assessment allows for a 1% probability of failure.

Figure 13 indicates that static case long-term analyses would require all individual analyses to have an FoS greater than 1.6. For the condition of temporary exposure of sand faces prior to placement of clay buttressing an FoS greater than 1.3 is required. For non-static, short-term rare events such as seismic events it is considered reasonable to reduce the acceptance criteria in line with Figure 14 above. This is consistent with the absence of evidence of ground deformation resulting from the Mansfield earthquake in 2021.

6.1.4 Consequence Category for Embankments/Impoundments

The consequence category defined by ANCOLD (2012, 2019) is assigned based on various conditions and it influences the acceptable forms of analysis. During the operational phase of the sand extraction project, a small number of personnel are expected to be present in the working areas of the pits. In relation to water and tailings impoundment at the site, the number of personnel potentially at risk (population at risk) in a working area that could be inundated would be expected to be between 1-10.

The inundation of an adjacent working pit from water or tailings in an adjacent storage would endanger the lives of those working in the pit. Therefore a “High C” consequence category is assigned based on ANCOLD (2012,2019).

For a consequence category High C, pseudo-static limit-equilibrium analysis is used as a screening tool for stability as indicated above. If FoS is below 1.1, assessment of the potential deformation/settlement of the embankment resulting from earthquake activity is required.

According to ANCOLD (2019) “Operating Basis Earthquake (OBE) -–The OBE is that level of ground motion at the dam site which leads to only minor damage. The dam, appurtenant structures and equipment should remain functional and damage from the occurrence of an earthquake not exceeding the OBE should be easily repairable.” An Operational Basis Earthquake (OBE) for High C consequence category is defined in ANCOLD (2012,2019) as 1:475 years annual exceedance probability (AEP) Therefore a value of peak ground acceleration of 0.055g was adopted for the seismic stability analyses for the site.

A Safety Evaluation Earthquake (SEE) is defined in ANCOLD (2012,2019) as 1:2500 years annual exceedance probability (AEP) therefore a value of peak ground acceleration of 0.16g was adopted for the seismic stability analyses for the ‘post-closure’, i.e. rehabilitation conditions for the site.

6.2 Stability Analysis

6.2.1 Potential Failure Mechanisms

At exposed faces of sand and/or clay the circular, rotational mechanism at a range of scales is likely to be the main process of potential failure (Figure 17A). After the placement of clay buttresses groundwater pressure is applied to the clay-sand interfaces and has the potential to induce sliding into the pit (Figure 17B).

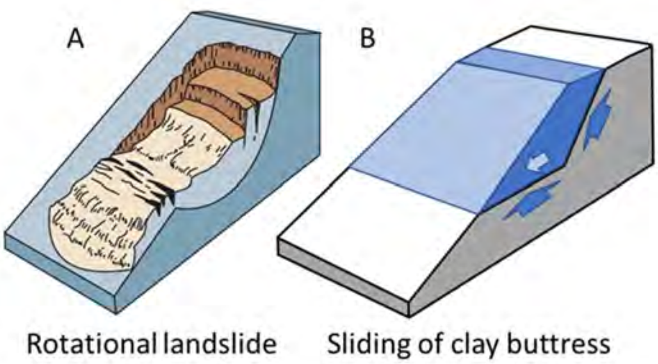

Figure 17: A) Illustration of the rotational landslide failure mechanism, AGS 2007C Practice Note Guidelines of Landslide Risk Assessment. B) Illustration of potential sliding of clay buttress under the influence of water pressure

6.2.2 Analysis Results – Excavated and Buttressed Slopes

6.2.2.1 Rotational Failure

Deterministic limit-equilibrium analysis using the software SLIDE2 (Rocscience) was conducted on a profile representing the geological conditions on the northern boundary of the expansion area. Configurations were varied by incorporating a buttress of clay in the upper slope and by considering various gradients in the lower slope (9m to -9m elevations).

The recommendation for slopes in the deeper excavations have been selected as the long-term terminal and rehabilitated slopes which achieve >1.6 without seismic loading, operational slopes (including slopes prior to buttress placement) which achieve >1.3 and seismic loading (1:500 year) which achieves >1.1.

Where clay is present, a static analysis has been conducted for two strength conditions, namely undrained shear strength and drained shear strength. For the seismic analyses, undrained shear strength has been used for clay materials.

The water table adopted was inferred from modelled groundwater conditions and the condition of the presence of the waterway diversion on the ground surface above the slope face.

The stratigraphic distribution of materials has been modelled to represent four parts of the proposed excavation area with attention to the perimeter areas adjacent to the property boundaries.

Table 22 summarises the stratigraphic conditions used to model the various parts of the proposed expansion.

Table 22: Stratigraphy for Stability Modelling				
Strata type	Northwest	North Central	Northeast 1	Northeast 2
	Depth of top and base below ground level (m)			
Clay	0-8.5	0-5	0-7	0-3
Sand	8.5-9.5	5-6	7-14	3-11
Clay	-	6-7.5	-	-
Organic Sand	9.5-15	-	14-15.5	11-depth
Sand	-	7.5-14	15.5-19	
Clayey sand	15-22.5			
Organic Sand	22.5-depth	14-15	19-21	
Sand		15-22	21-22	
Organic Sand		22-depth	22-depth	

Sand – pale yellow/grey i.e. not organic sand. 'Depth' refers to no further material type detected.

Factor of safety determined by limit-equilibrium (Slide2 V.9, RocScience) are provided in Table 23. Illustrative outputs shown in Appendix C1. The factors of safety are the minimum value for the slope regardless of the size of failure.

Table 23: Summary of slope stability analyses in expansion area (Appendix C1)					
Case	**Location**	**Conditions**	**Load case**	**Min. FoS**	**Acceptable**
1	NW	Excavation to +9m RL at 1:2.5 Prior to buttress emplacement Drained clay material properties	Static	1.72	Yes
2	NC	As above		1.69	Yes
3	NE1	As above		1.75	Yes
4	NE2	As above		1.70	Yes
5	NW	Excavation to +9m RL at 1:2.5 Prior to buttress emplacement Undrained clay material properties for clay buttress	Seismic	1.54	Yes
6	NC	As above		1.47	Yes
7	NE1	As above		1.49	Yes
8	NE2	As above		1.46	Yes
9	NW	Excavation to +9m RL at 1:2.5 Buttress emplaced Drained clay material properties	Static	1.97	Yes
10	NC	As above		1.97	Yes
11	NE1	As above		1.97	Yes
12	NE2	As above		1.97	Yes
13	NW	Excavation to +9m RL at 1:2.5 Buttress emplaced Undrained clay material properties for clay buttress	Seismic	2.11	Yes
14	NC	As above		2.17	Yes
15	NE1	As above		2.14	Yes
16	NE2	As above		2.11	Yes
17	NW	Dredged excavation to -9m RL at 1:2 Buttress emplaced Drained clay material properties	Static	1.61	Yes
18	NC	As above		1.57	Yes*
19	NE1	As above		1.63	Yes
20	NE2	As above		1.62	Yes
21	NW	Dredged excavation to -9m RL at 1:2 Buttress emplaced Undrained clay material properties for clay buttress	Seismic	1.42	Yes
22	NC	As above		1.21	Yes
23	NE1	As above		1.21	Yes
24	NE2	As above		1.44	Yes
25	NW	As above with water at rehabilitation level	Static	1.79	Yes
26	NC	As above		1.57	Yes*
27	NE1	As above		1.58	Yes*
28	NE2	As above		1.83	Yes
*Marginally below FoS 1.6 for surficial slip circles, FoS >1.6 for slip circles penetrating 1 m into slope face					

6.2.2.2 Buttress Sliding

Deterministic limit-equilibrium analysis using the software Rocplane (Rocscience) was conducted on a profile representing the proposed dimensions of the clay buttress. In this potential failure mechanism water pressure is applied at the sand-clay interfaces. The potential sliding would occur parallel to the base of the buttress. The failure would occur through the weakest material which could be the a) clay buttress material, b) clay-sand interface or c) through the sand.

Sliding stability analysis has been conducted for cases as summarised in Table 24 and illustrated in Appendix C.

Table 24: Summary of buttress sliding stability analyses (Appendix C)

Case	Properties	Factor of safety	Acceptable
Excavation to +9m RL Top of buttress 30m wide (typical case at site)	Undrained shear strength of clay (75 kPa)	2.31	Yes
	Drained effective friction angle of (36°), cohesion zero.	2.42	Yes
	Undrained shear strength of clay (75 kPa) at seismic conditions	1.60	Yes

6.3 Analysis of Embankments

Sections 6.3.1 to 6.3.5 describe limit-equilibrium analysis conducted on existing and proposed embankments to determine minimum FoS. Figure 18 below shows the approximate location of analysed sections. Please refer to Appendix A3 Figure 05 for an overall site plan with the analysed section.

Figure 18: Locations of analysed embankments relative to conducted CPTu tests

6.3.1 Analysis of Embankment A – Section A-A’

During the site investigation a CPT probe was driven through the previously placed mud impoundment, centrally located in Figure 18, to the east of CPT-03A. Limit-equilibrium analysis was conducted on a representative section of a mud deposition site through its adjacent land bridge/embankment wall. The analysis showed that the existing configuration of the wall segment analysed has acceptable safety factor (Table 23). Refer to Appendix C2 Case 1 and 2 for analysis results at section A-A’ shown in Figure 18.

6.3.2 Analysis of Embankment B – Section B-B’

A CPT probe was driven through the existing land bridge running east to west through the western pit. Limit equilibrium was conducted on a representative section of the landbridge in close proximity to the location of CPT-01C. The analysis showed that the existing configuration of the wall segment analysed has acceptable safety factor (Table 23). Refer to Appendix C2 Case 3 and 4 for analysis results at section B-B’ shown in Figure 18.

6.3.3 Analysis of Embankment C – Section C-C’

Limit equilibrium analysis was conducted on a representative section of the mud deposition site through a proposed embankment to the north as shown in Figure 18. The analysis showed that the proposed configuration of the wall segment analysed has acceptable safety factor (Table 23). Refer to Appendix C2 Case 5 and 6 for analysis results at section C-C’ shown in Figure 18.

6.3.4 Analysis of Embankment D – Section D-D’

A section was analysed through the proposed dam wall delineating the proposed expansion and a proposed water storage in the eastern pit, as shown in Figure 18. The analysis showed that the proposed configuration of the wall segment analysed has acceptable safety factor (Table 23). Refer to Appendix C2 Case 7 and 8 for analysis results at section D-D’ shown in Figure 18.

6.3.5 Analysis of Embankment E – Section E-E’

A section through the proposed dam wall delineating the proposed water storage (northern area) and filter cake impoundment (southern area) in the eastern pit, as shown in Figure 18. The analysis showed that the proposed configuration of the wall segment analysed has acceptable safety factor (Table 25). Refer to Appendix C2 Case 9 and 10 for analysis results at section E-E’ shown in Figure 18.

Table 25: Summary of slope stability analyses for internal embankments (Appendix C2)

Case	Conditions	Load case	Min FoS	Acceptable
C2-1	Embankment A – impoundment Drained material properties, buttress	Static	2.31	Yes
C2-2a	Embankment A – impoundment Drained material properties, buttress	Seismic (0.055g)	2.00	Yes
C2-2b	Embankment A – impoundment Undrained clay material properties	Seismic (0.055g)	2.37	Yes
C2-2c	Embankment A – impoundment Recovered water table	Seismic (0.16g)	1.86	Yes
C2-3	Embankment B – landbridge western pit @ 1:2.2 both slopes Drained clay material properties	Static	1.54	Yes
C2-4a	Embankment B – landbridge western pit @ 1:2.2 both slopes Drained clay material properties	Seismic (0.055g)	1.33	Yes
C2-4b	Embankment B – landbridge western pit @ 1:2.2 both slopes Undrained clay material properties	Seismic (0.055g)	1.60	Yes
C2-4c	Embankment B – landbridge western pit @ 1:2.2 both slopes Recovered water table	Seismic (0.16g)	1.49	Yes
C2-5	Embankment C – central impoundment @ 1:2.5 northern slope, 1:2 southern slope Drained clay material properties	Static	1.87	Yes
C2-6a	Embankment C – central impoundment @ 1:2.5 northern slope, 1:2 southern slope Drained clay material properties	Seismic (0.055g)	1.59	Yes
C2-6b	Embankment C – central impoundment @ 1:2.5 northern slope, 1:2 southern slope Undrained clay material properties	Seismic (0.055g)	1.80	Yes
C2-6c	Embankment C – central impoundment @ 1:2.5 northern slope, 1:2 southern slope Recovered water table	Yes (0.16g)	1.48	Yes
C2-7	Embankment D – eastern storage @ 1:3 both slopes Drained clay material properties	Static	1.63	Yes
C2-8a	Embankment D – eastern storage @ 1:3 both slopes Drained clay material properties	Seismic (0.055g)	1.37	Yes
C2-8b	Embankment D – eastern storage @ 1:3 both slopes Undrained clay material properties	Seismic (0.055g)	1.76	Yes
C2-8c	Embankment D – eastern storage @ 1:3 both slopes Recovered water table	Seismic (0.16g)	1.41	Yes
C2-9	Embankment E – eastern pit storage @ 1:3 both slopes Drained clay material properties	Static	2.02	Yes
C2-10a	Embankment E – eastern pit storage @ 1:3 both slopes Drained clay material properties	Seismic (0.055g)	1.70	Yes

Table 25: Summary of slope stability analyses for internal embankments (Appendix C2)				
Case	**Conditions**	**Load case**	**Min FoS**	**Acceptable**
C2-10b	Embankment E – eastern pit storage @ 1:3 both slopes Undrained clay material properties	Seismic (0.055g)	2.41	Yes
C2-10c	Embankment E – eastern pit storage @ 1:3 both slopes Recovered water table	Seismic (0.16g)	2.01	Yes

7 SLOPE RECOMMENDATIONS

Slope recommendations are based on achieving safe, stable sustainable slopes during operation and in the rehabilitated condition.

Due to the need to construct a waterway diversion, the excavation will occur in two main stages comprising an upper slope, which will include formation of the initial clay buttress and the waterway diversion, and a lower slope that will be formed when excavation accesses the area presently occupied by the natural waterway.

Based on the slope features outlined above, the excavation can be considered to comprise an upper slope and a lower slope. The main slope features are illustrated in Figure 19. The slope geometries analysed are illustrated in Appendix C. Buttressing of the upper slope can be conducted in a series of stages.

The initial excavation is limited in size by the temporary preservation of the existing water way. The distance between the northern property boundary and the existing waterway varies along the length of the northern boundary. The distance is at its maximum in the centre of the proposed excavation and minimum at the west and east ends of the excavation. The initial excavation is also affected by the width of buffer zone required for the existing waterway and the width of the pit floor required for operational requirements.

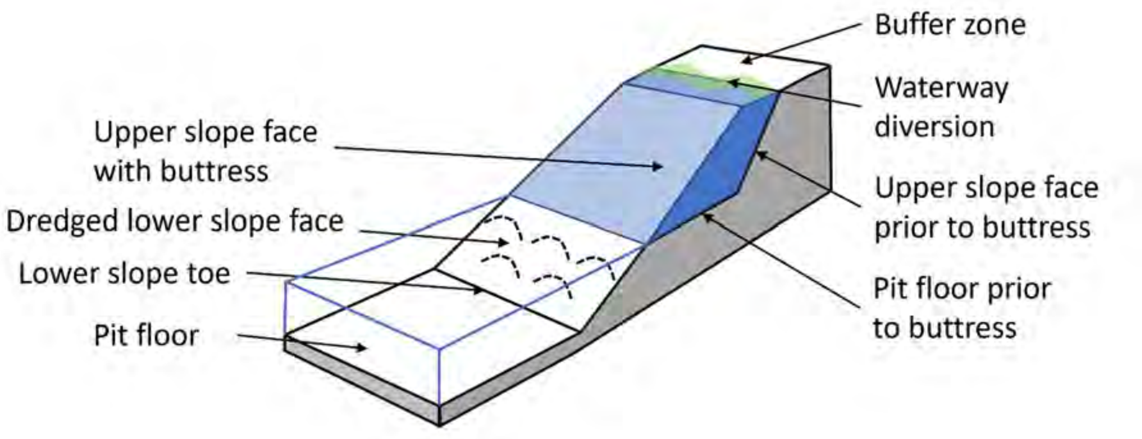

Figure 19: Annotated schematic illustration of the proposed pit slope features

7.1 Upper Slope

The upper slope is considered to be the part of the face which is excavated to the depth at which the initial clay buffer would be installed. This depth may vary but is inferred to be similar to the depth of excavation of the existing pits at the site at 9 m RL. This depth is approximately 16 m below the typical ground elevation in the northern part of the site.

A bench may be constructed at the top of the sand (i.e. below the clay) to facilitate vehicle movement. These slope faces would be exposed temporarily as clay overburden will be placed as a clay buttress.

- A slope angle/gradient of 1:2.5 (V:H) for excavated upper slopes is recommended.
- A slope angle/gradient of 1:3 (V:H) for the upper face of the clay buttress slopes is recommended. It is understood that the upper face for rehabilitation will be 1:5 (V:H) to the final pit water level which is expected to be in the vicinity of 23 m RL.
- The width of the upper surface of the clay buttress should be a minimum of 30 m but is required to be wider along the northern perimeter, according to the design of the waterway diversion. The current waterway diversion design provided requires 58m width at the top of the clay buttress.

The buttress is to be formed progressively as overburden clay is stripped from other parts of the site.

7.2 Lower Slopes

The lower slopes are to be excavated by dredging. Stability analysis indicates that a slope of 1:2 (V:H) is adequately stable for slopes in sand below the pond water level. This analysis is based on material properties of zero cohesion and 38^{o} friction angle as derived from this investigation.

Dredging equipment typically utilises rotational movements of a suction boom such that concave faces in the horizontal and vertical faces are formed. The recommended slope gradient may be achieved by forming benches in the excavation process. Ensuring the gradient is not over steepened requires careful placement of tethering lines and control of excavation face locations.

7.3 Embankments

Stability analysis indicates the maximum embankment slopes and minimum slope widths as provided in Table 26 are required to achieve adequate stability in static and seismic conditions.

Table 26: Summary of analysed minimum crest width and maximum slope				
Embankment ID.	**Embankment Existing or Proposed**	**Minimum Crest Width (m)**	**Overall slope (V:H)**	**Acceptable**
A	Existing	12.25	1:<3.3 (variable slope)	Yes
B	Existing	8.00	1:2.2	Yes
C	Proposed	15.00	1:2.5 northern slope	Yes
D	Proposed	15.00	1:3.0	Yes
E	Proposed	15.00	1:3.0	Yes

7.4 Erosion

According to Ford et al. (1993) Yannathan is at the boundary of zones mapped as 'limited occurrence of sodic soils' (northwest of Yannathan) and 'neutral sodic soils' (southeast of Yannathan). The soils in the area have not been identified as being highly susceptible to gully erosion or tunnel erosion.

Exposed sand faces are highly erodible. Slopes which have been covered by a clay buttress and grass cover showed resistance to erosion (e.g. Figure 20). The battered slopes and slope crests drain toward existing ponds on the site. The rehabilitation profile will include a 1:5 slope above water level which will further reduce erosion risk. It is recommended that the grassed slopes at Yannathan continue to be visually monitored to demonstrate erosional stability.

Discussion about performance of existing slopes…etc

Figure 20: Grass cover on batters of the west pit (facing southwest 11 January 2023)

The existing waterway diversion does not show signs of erosion. The waterway has been constructed with intermittent ponds with rock armoured outlets to control flow velocities and limit scouring potential.

Exposed faces in sand or unvegetated faces of clay are anticipated to undergo surficial rilling erosion.

The grass-covered clay batter faces are expected to have low erosion potential as per empirical findings in similar climatic conditions (Basher 2013). The Universal Soil Loss Equation and its variants are not considered directly applicable to the case of very small catchment slopes.

Universal soil loss equation (USLE) parameters using the Hamburg University of Technology (TUHH) https://www.ruvival.de/soil-erosion-calculator/Universal Soil Loss Equation (USLE) are shown in Table 27. This equation integrates the local rainfall pattern, soil type, topography, crop system and management practices. RUSLE is an improved formula, that can handle more complex combinations of tillage and cropping practices and a greater variety of slopes.

Table 27: Erosion Model Parameters		
Parameter	**Value range 1**	**Value range 2**
Erosivity Factor (Rainfall Factor) [(MJ mm) / (ha hr)]	1000	1800
Soil Erodibility [(t / ha)]	0.49	0.49
Slope [%]	20	20
Slope Length [m]	20	20
Crop Type Factor	0.02	0.02
Tillage Factor	0.25	0.25
Annual Average Soil Erosion Rate (t/ha/yr)	2.09	3.77
Classification	Very low (tolerable)	Very low (tolerable)

The proposed soils for the buttress are understood not to be highly dispersive. The specification will be updated to reflect that the final soils used in the buttress are to be tested for dispersion. Where the soils are found to be dispersive then they will be replaced with alternate materials or appropriately treated (e.g. dispersive behaviour can be controlled by addition of lime). Fell, R., 2005. Geotechnical engineering of dams. CRC press.

8 GEOTECHNICAL RISK ASSESSMENT

8.1 Anticipated Operating Conditions

For the geotechnical qualitative and semi-quantitative risk assessments, the following assumptions have been made:

1. The methods of extraction in the proposed area of quarry will be summarised as:
    a. Dry excavation by mechanical means to +9 mRL (similar to current operation depths). Water to be removed from the pit by pumping from a floor sump.
    b. The placement of clay fill buttress is intended to stabilise slopes and control groundwater inflow (similar to current operational practice). Diversion of an existing waterway to the northern clay buttress embankment.
    c. Dredge excavation to a level of -9 mRL. The dredge pond size and water level would vary according to operational requirements.

2. Subsurface conditions are expected to be similar to those observed in the geotechnical boreholes and adjacent quarry site pits and faces.
3. Assumed water table level is 0-5 m below ground level within the area of proposed excavation that will undergo the initial excavation. The water table elevation will be monitored during excavation to assess its impact on the stability.

8.2 Risk Assessment Methodology

The Risk Assessment follows the methodology outlined in the ERR document Geotechnical guideline for terminal and rehabilitated slopes, Extractive Industry projects' (September 2020). The content of the Risk Assessment also follows the framework of the ERR, Preparation of Work Plans and Work Plan Variations, Guideline for Extractive Industry Projects V1.3 December 2020. The Risk Assessment was conducted as part of the by geotechnical assessment by a nominated competent person (further information on methodology is included in the Risk Assessment in Appendix D).

The geotechnical assessment proceeded through hazard identification and a qualitative risk assessment. The risk assessment framework used is a matrix of risk level based on defined likelihood and consequence categories. Controls to achieve mitigation of risks are outlined and the resulting reduction in residual risk was assessed.

ERR Geotechnical Guidelines 2020 indicate that "Inherent risks should be based on the project description in your work plan and should be assessed on the basis that there are no control measures in place."

A summary of extraction stages and associated risks is presented in Table 28.

Table 28: Summary of extraction stages and risks (see Appendix D)

Stage	**Comment**	**Conditions related to Inherent risks**	**Controls to reduce Residual risks (Summary)**	**Appendix D risk ID**
Extraction at northern* face prior to buttress emplacement, prior to waterway diversion construction (*other faces are also considered)	Depth limited by location of waterway prior to diversion.	Presence of Westernport Rd – potential influence of slumping (including seismic conditions)	Limiting the face-length and time of exposure prior to buttress placement	1a
		Presence of Westernport Rd – potential influence of subsidence from water table drawdown		2a
Extraction at northern* face		Large-scale slope instability by rotational	Careful control of dredge extraction	1b

Table 28: Summary of extraction stages and risks (see Appendix D)				
Stage	**Comment**	**Conditions related to Inherent risks**	**Controls to reduce Residual risks (Summary)**	**Appendix D risk ID**
after buttress emplacement, after waterway diversion construction (*other faces are also considered)	Extraction to maximum depth Dredging from approximately +9 mRL	failure or sliding of the buttress under effects of water pressure	limit to conform to overall slope gradient. Dredge extraction benches to be defined according to dredge boom geometry.	
		Presence of Westernport Rd – potential influence of subsidence from water table drawdown	Monitor road condition and slope crests and faces	2b
		Excessive leakage of waterway diversion	Monitor waterway condition	3
		Slumping or heave at operational toe due to high water pressure (including seismic conditions or excessive dredging undercutting slope)	Monitor exposed faces and dredging operational face condition	4
Operation and Rehabilitation	Erosion of batters	Tunnel erosion or piping leading to slope failure	Ensure clay batters develop grass cover	5
Operation and Rehabilitation	Internal embankment failure	Collapse of embankment impounding water and/or solid waste (including seismic conditions)	Construct according to design based on site investigation	6

8.2.1 Water Table Drawdown

Water table drawdown can result in settlement of soil layers by the loss of water pressure. The settlement can occur quickly in sand or more slowly in clay soils.

The risk of damage to buildings and other infrastructure depends on the total and differential settlements that occur, and the tolerance of structures to settlement, in particular the differential settlement. Buildings and roads are typically not significantly impacted by differential movement in the order of 1/500.

CMW understand that hydrogeological modelling by GWS (2021) indicates only small amounts of water table drawdown are expected. This outcome is to be achieved by exposing limited lengths of sand faces for limited time before covering with a substantial buttress of clay from the overburden. The use of dredge mining below +9 mRL also reduces the expected water table drawdown in comparison to dry extraction to the same depth.

8.3 Risk Assessment Outcomes

The proposed slopes have not yet been constructed so the inherent risk does not represent a currently existing risk. The inherent risk ratings have been selected to represent the condition without application of the proposed risk controls. A number of these proposed risk controls are routinely applied at the existing slopes at the site, for example, the clay buttressing of slopes. Therefore, the risk assessment chart is intended to represent the impact of the risk control measures from low level of control being 'inherent' to greater control being 'residual' risk levels.

Hazards identified for the terminal faces are listed below.

- Rotational failure/buttress sliding +/- seismic event before and after clay buttress emplaced (medium -> medium),
- Settlement/subsidence before and after clay buttress emplaced (medium -> low),
- Waterway diversion failure (medium -> low),
- Slumping or heave at operational slope toe (medium->medium),
- Ineffectively rehabilitated slopes (medium->low),

Control measures are outlined in the matrix in Appendix D. The Risk Assessment presented in Appendix D demonstrates that the potential Inherent Risks can be controlled to the extent that a number are reduced to Residual Risk Ratings of Low to Medium. Risk controls and trigger action response plans are outlined in the ground control management plan provided as a separate document.

CMW believes that in the context of the proposed extraction, the Residual Risk Ratings have been reduced as far as is reasonably practicable.

8.4 Embankment/Impoundment Risks

An existing embankment impounding water and an existing embankment impounding fine solid waste were analysed to assess stability. Three embankments intended for construction comprising one excavation adjacent to a solid waste impoundment and two embankments for internal water impoundment were analysed. These five embankments were found to have adequate stability as assessed according to ANCOLD (2012, 2019) tailings guidelines. The embankment walls of tailings impoundments on the site must be regularly inspected to observe signs of damage or distress. The principal signs are expected to be 1) changes to the rate or character (e.g. cloudiness) of water emanating from the embankment face and 2) cracking or settlement observed on the face or crest of the embankment. Unexpected settlement of the impounded solid waste should also be considered a potential sign of instability of the embankments surrounding the impoundment.

9 CONCLUSIONS AND RECOMMENDATIONS

Based on the above investigation and geotechnical risk assessment, the following conclusions and recommendations are provided:

CMW Geosciences (CMW) has been engaged by Hanson Construction Materials (Hanson) to carry out a geotechnical assessment for the planned expansion of the sand quarry at Yannathan, in the State of Victoria. The study and proposed Work Plan Variation are being coordinated by Ricardo Energy, Environment and Planning (Ricardo).

CMW was engaged as a geotechnical specialist consultant to assist Hanson during the application for the proposed sand quarry. The geotechnical assessment and analysis presented in this report has been prepared for the proposed expansion project.

Based on the agreed scope of works the following findings are presented:

1. A desktop study was conducted including a detailed review of relevant site information, existing mapping data and site hydrogeological investigations. The study was supported by a site walkover by the authors of this report. The results of laboratory testing of organic sand from a 30 m deep drillhole at Lang Lang sand quarry 5 km southwest of this site has also been included in the desktop review. Testing of organic sand at Yannathan, such as particle size distribution by sieving and particle density tests, could be used to demonstrate equivalence with the organic sands investigated at Lang Lang. The author of this report has observed both materials and considers the material parameters to be equivalent.

2. A site geological and geotechnical model was developed based on the results of the desktop review.

3. Geotechnical field investigation consisting of CPTu, DPSH and DCP testing. Including, analysis of CPTu data to classify subsurface material and develop geotechnical sections and estimation of material parameters and classification of material density / stiffness from CPTu, DPSH and DCP data.

4. Slope stability analyses have been conducted using batter geometry profiles discussed during the site walkover and in communication with clients. Limit-equilibrium analyses of rotational slope failure and sliding of the clay buttress under the effect of water pressure have been conducted. The upper slopes (+9m RL to surface) would be excavated at 1:2.5 (V:H) and buttressed following excavation with clay fill at terminal/rehabilitated faces, at a gradient of 1:3 (V:H). A gradient of 1:5 (V:H) would be incorporated in the slope from surface to the expected rehabilitated water level. Water inflow from sand faces and water pressure on the clay buttress will increase as excavation depth increases. It is recommended that these parameters are carefully recorded as the excavation proceeds below +9 mRL so that models and assumptions can be confirmed with the observations. Deepening of the excavation to -9 mRL by dredging has been included in the analysis. The dredged lower slopes can be excavated at 1:2 (V:H).

5. The factors of safety (FoS) of the upper slope (+9 mRL to surface) with a clay buttress emplaced are above 1.6 for static conditions. The sand slopes prior to buttressing have FoS less than 1.6 and are assessed as acceptably stable based on the site experience of placing buttresses following excavation. Operational upper slopes in sand at a gradient of 1:2.5 are expected to be stable on the basis that limited faces are exposed prior to placing of clay buttressing on terminal/rehabilitated slopes. The lower slope could be excavated by dredging at a gradient of 1:2 (V:H). The dredging boom geometry should be assessed to identify a series of cutting faces that will conform to the overall recommended gradient.

6. The stability of the proposed design batter geometries for the operational, terminal and rehabilitation geometries has been assessed in accordance with the Department of Jobs, Precincts and Regions (DJPR) 2020 'Geotechnical guideline for terminal and rehabilitated slopes – Extractives Industry Projects'. The recommended slopes meet stability requirements.

7. The slopes of embankments for impoundments of water and fine waste materials have also been assessed with reference to the ANCOLD (2012, 2019) guideline on tailings dams. The recommended slopes meet stability requirements.

8. The slope stability analyses also show that the recommended slopes are stable for a 1 in 500 year seismic event. The stability of the slope profile and long-term (rehabilitation) water level has been evaluated for the constructed embankments for impoundments for a 1:2500 year seismic event following ANCOLD (2012, 2019).

9. The geotechnical risk assessment has identified suitable risk treatment protocols for identified hazards. The residual risks are considered to be low or medium.

10. Preliminary consideration of the erodibility of the proposed rehabilitation slope design indicate that a final slope with low erosion potential can be achieved at the site.

11. This geotechnical assessment report outlines the findings and recommendations, which support a Work Plan Variation for the proposed expansion area.

12. A Ground Control Management Plan (GCMP) incorporating trigger action response plans (TARPs) is provided as a separate report.

13. A fill specification to facilitate construction of waterway is included as an Appendix to this report.

13 a. It is understood that the waterway is to be located over clay buttressing placed along the northern perimeter of the proposed expansion area. The clay fill, if placed in accordance with the specifications provided, is expected to provide an appropriate limit to infiltration to allow the constructed waterway to perform in a similar way to natural waterways in the area. The thickness of the clay buttress is expected to prevent water infiltration to represent a risk to the excavation in the expansion area. An artificial lining is not recommended if the fill specifications for material selection, methods of compaction and testing are achieved.

13 b. Monitoring requirements to ensure that the constructed waterway does not create a risk to the excavation area are visual observations and surveying as outlined in the risk assessment in this report and GCMP.

10 CLOSURE

The findings contained within this report are the result of limited discrete investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all locations.

If the ground conditions encountered during construction are significantly different from those described in this report and on which the conclusions and recommendations were based, then we must be notified immediately.

Additional important information regarding the use of your CMW report is provided in the 'Using your CMW Report' document attached to this report.

This report has been prepared for use by Hanson Construction Materials, c/o Ricardo Energy, Environment and Planning in relation to the 870-910 Westernport Road Yannathan, Victoria 3984 project in accordance with the scope, proposed uses and limitations described in the report. Should you have further questions relating to the use of your report please do not hesitate to contact us.

Where a party other than Hanson Construction Materials, c/o Ricardo Energy, Environment and Planning seeks to rely upon or otherwise use this report, the consent of CMW should be sought prior to any such use. CMW can then advise whether the report and its contents are suitable for the intended use by the other party.

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USING YOUR CMW GEOTECHNICAL REPORT

Geotechnical reporting relies on interpretation of facts and collected information using experience, professional judgement, and opinion. As such it generally has a level of uncertainty attached to it, which is often far less exact than other engineering design disciplines. The notes below provide general advice on what can be reasonably expected from your report and the inherent limitations of a geotechnical report.

Preparation of your report

Your geotechnical report has been written for your use on your project. The contents of your report may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted Geotechnical Engineering and Engineering Geology practices and procedures. The opinions and conclusions reached in your report are made in accordance with these accepted principles. Specific items of geotechnical or geological importance are highlighted in the report.

In producing your report, we have relied on the information which is referenced or summarised in the report. If further information becomes available or the nature of your project changes, then the findings in this report may no longer be appropriate. In such cases the report must be reviewed, and any necessary changes must be made by us.

Your geotechnical report is based on your project's requirements

Your geotechnical report has been developed based on your specific project requirements and only applies to the site in this report. Project requirements could include the type of works being undertaken; project locality, size and configuration; the location of any structures on or around the site; the presence of underground utilities; proposed design methodology; the duration or design life of the works; and construction method and/or sequencing.

The information or advice in your geotechnical report should not be applied to any other project given the intrinsic differences between different projects and site locations. Similarly geotechnical information, data and conclusions from other sites and projects may not be relevant or appropriate for your project.

Interpretation of geotechnical data

Site investigations identify subsurface conditions at discrete locations. Additional geotechnical information (e.g. literature and external data source review, laboratory testing etc) are interpreted by Geologists or Engineers to provide an opinion about a site specific ground models, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist due to the variability of geological environments. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. Interpretation of factual data can be influenced by design and/or construction methods. Where these methods change review of the interpretation in the report may be required.

Subsurface conditions can change

Subsurface conditions are created by natural processes and then can be altered anthropically or over time. For example, groundwater levels can vary with time or activities adjacent to your site, fill may be placed on a site, or the consistency of near surface conditions might be susceptible to seasonal changes. The report is based on conditions which existed at the time of investigation. It is important to confirm whether conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation and use by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. To help avoid misinterpretations, it is important to retain the assistance of CMW to work with other project design professionals who are affected by the contents of your report. CMW staff can explain the report implications to design professionals and then review design plans and specifications to see that they have correctly incorporated the findings of this report.

Your report's recommendations require confirmation during construction

Your report is based on site conditions as revealed through selective point sampling. Engineering judgement is then applied to assess how indicative of actual conditions throughout an area the point sampling might be. Any assumptions made cannot be substantiated until construction is complete. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances from previous assumption, conduct additional tests if required and recommend solutions to problems encountered on site.

A Geotechnical Engineer, who is fully familiar with the site and the background information, can assess whether the report's recommendations remain valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Environmental Matters Are Not Covered

Unless specifically discussed in your report environmental matters are not covered by a CMW Geotechnical Report. Environmental matters might include the level of contaminants present of the site covered by this report, potential uses or treatment of contaminated materials or the disposal of contaminated materials. These matters can be complex and are often governed by specific legislation.

The personnel, equipment, and techniques used to perform an environmental study can differ significantly from those used in this report. For that reason, our report does not provide environmental recommendations. Unanticipated subsurface environmental problems can have large consequences for your site. If you have not obtained your own environmental information about the project site, ask your CMW contact about how to find environmental risk-management guidance.

Appendix A1: Site Walkover Photographs (2022)

Appendix A2: Field Investigation Photographs (2023)

Appendix A3: Site Plans

Appendix B1: CPT IGS Results

Appendix B2: CPT CMW Analysis

Appendix B3: CLiq CMW Analysis

Appendix B4: DPSH Results

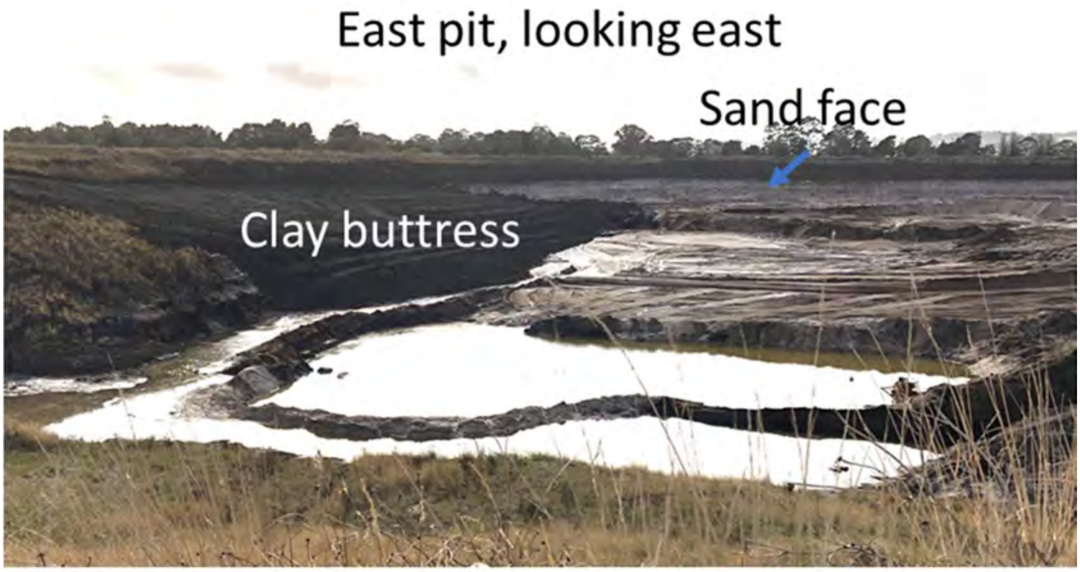
Appendix B5: DCP Results

Appendix C: Slope Stability Analysis Outputs

Appendix D: Geotechnical Risk Assessment

Appendix E: Waterway Diversion Specification

Appendix A – Field Photographs



Temporary clay buttress on the north side of the east pit

West pit, east wall, looking southeast


West pit, north wall, looking northwest
Top of organic sand lens
1UN 7NX


West pit, west wall profile, looking south
1UN 7NX


Expansion area, looking north to northeast
Northern bund

Appendix A2: Field Investigation Photographs (2023)

CPT-01 - LOOKING SOUTH - 11/01/2023

CPT-01 - EXIT SURVEY - 11/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN:	SP	PROJECT NO:	MEL2022-0033AE
	PROJECT: **YANNATHAN SAND QUARRY GEOTECHNICAL INVESTIGATION**	CHECKED:	JVS	DRAWING REF:	Attachment A2
		REVISION:	1	PAGE	1
	TITLE: **SITE PHOTOS**	DATE:	6/02/2023	SIZE/SHEET:	A4

CPT-01A - LOOKING SOUTH - 11/01/2023

CPT-01A - EXIT SURVEY - 11/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 2
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-01B - LOOKING SOUTH - 11/01/2023

CPT-01B - EXIT SURVEY - 11/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 3
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-2A - LOOKING WEST - 11/01/2023

CPT-02B - EXIT SURVEY - 11/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN:	SP	PROJECT NO:	MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED:	JVS	DRAWING REF:	Attachment A2
		REVISION:	1	PAGE	4
	TITLE: **SITE PHOTOS**	DATE:	6/02/2023	SIZE/SHEET:	A4

CPT-2C - LOOKING WEST - 12/01/2023

CPT-02C - EXIT SURVEY - 12/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 5
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-2D - LOOKING EAST - 12/01/2023

CPT-02D - EXIT SURVEY - 12/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 6
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-2F - LOOKING EAST - 12/01/2023

CPT-03A - LOOKING EAST - 12/01/2023

CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
	REVISION: 1	PAGE 7
TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-3A - MUD SPRAY - 12/01/2023

CPT-03A - OUTRIGGER DEPRESSION - 12/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 8
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-3A - TIRE DEPRESSION - 12/01/2023

CPT-03A - SURFACE CRACKING - 12/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 9
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-1C - LOOKING WEST - 13/01/2023

CPT-1C - EXIT SURVEY - 13/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 10
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

CPT-2G - LOOKING NORTH - 13/01/2023

CPT-2G - EXIT SURVEY - 13/01/2023

CMW Geosciences	CLIENT: RESOURCECO	DRAWN: SP	PROJECT NO:	MEL2022-0033AE
	PROJECT: YANNATHAN GEOTECHNICAL ASSESSMENT	CHECKED: JVS	DRAWING REF:	Attachment A2
		REVISION: 1	PAGE	11
	TITLE: SITE PHOTOS	DATE: 6/02/2023	SIZE/SHEET:	A4

CPT-2G - EXIT SURVEY - 13/01/2023

DPSH-01A - LOOKING SOUTH - 13/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 12
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

DPSH-01A - EXIT SURVEY - 13/01/2023

DPSH-01A - LOOKING NORTHWEST - 13/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 13
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

DPSH-01B - EXIT SURVEY - 13/01/2023

DPSH-01C - LOOKING EAST - 13/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 14
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

DPSH-01C - EXIT SURVEY - 13/01/2023

WEST PIT SOUTHERN BATTER - FACING SOUTH - 11/01/2023

WEST PIT SOUTHERN BATTER - FACING SOUTH - 11/01/2023

WEST PIT WESTERN BATTER - FACING SOUTHWEST - 11/01/2023

CMW Geosciences	CLIENT: RESOURCECO	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: YANNATHAN GEOTECHNICAL ASSESSMENT	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 16
	TITLE: SITE PHOTOS	DATE: 6/02/2023	SIZE/SHEET: A4

WEST PIT WESTERN BATTER - FACING SOUTHWEST - 11/01/2023

WEST PIT WESTERN BATTER - FACING SOUTHWEST - 11/01/2023

CMW Geosciences	CLIENT: **RESOURCECO**	DRAWN: SP	PROJECT NO: MEL2022-0033AE
	PROJECT: **YANNATHAN GEOTECHNICAL ASSESSMENT**	CHECKED: JVS	DRAWING REF: Attachment A2
		REVISION: 1	PAGE 17
	TITLE: **SITE PHOTOS**	DATE: 6/02/2023	SIZE/SHEET: A4

Appendix A3: Site Plans